Mr. C. Rajagopalachari on Agricultural Education*

Principal, Ladies and Gentlemen,

I congratulate the prize winners, especially those who have won the college academic prizes. I say that I congratulate the academic prize winners first not because the athletic prizes are less important but because they are more relevant. The athletic prizes will be won by the boys of other colleges also but agricultural prizes can only be won by students here. So I put the college prizes first, the studies prizes first. As regards the athletic prizes, no wonder that the Agricultural College boys fare better than the other college boys because their studies are more or less athletic, whereby they are always in the open air except perhaps those who wish to sit with the microscope and things like that and get into the habit of looking down, and that too not in vain.

I must say that I am charmed with the cheerful, physical and animal spirit atmosphere here and even that I attribute to the open air with which you are gifted more than the other college boys. Your Principal has referred to the importance of agriculture, which has become a platitude during these times of war and famine. But I shall not stipulate that matter; I would only adopt a layman's attitude in regard to that matter. Food is all important; it has ever been important. It is not more important now than before. Without food we can neither fight wars nor live even in peace. While Europe goes to war once in a few years, we in India are fighting all the while. The people of Europe fight among themselves more than we in India do. It is a beautiful land of men. There is more communal fighting in India than there is in Europe. We here fight on communal differences but there in Europe even without communal differences they fight. They fight now and then, but we here have to fight poverty all the year round. We have been doing so for sometime past.

Our population is increasing not only by growth but by immigration as well and our British friends have annexed to India large tracts of beautiful lands to our country. They have lost some of these tracts for the time being. All these are questions of political and national significance.

Our customs are our laws by which we divide our lands whereby the eldest son gets all the land while the rest go out to other people's lands. I am here alluding to the fragmentation of the

* Speech delivered by Mr. C. Rajagopalachari on the "College Day" of the College of [illegible], Nagpur on 27th November, 1944

land in our country. Fragmentation of land has been in practice in our country from times immemorial and the land has all along been divided. We respect our laws always. We are a very law-abiding people. We never disobey laws. Not even a king or a Government is necessary for our land. Our chronic character is obedience to law for which no king or assembly is needed but merely a social conscience is enough and we have been dividing our lands according to the law. Imagine hundreds of generations going on dividing land like that until a money-lender came and took it all to himself. It is only the money-lender that saved the fragmentation of land in our conutry. So let us pay the devil its due. Let us thank the money-lender for bringing our lands together, to some extent. To the theoretical arithmetician fragmentation may mean no harm, as in his estimation the total quantity of food may be the same, but able agriculturists as you are, you know that fragmentation means reduction in production, and it has been going on like that in our country.

I need not refer to other matters here. On the whole we want more food. Whether there is war or there is peace, we want more food. Our Government is now very keenly alive to the necessity of having more food. They are doing their best in their power. Food is equitably distributed as far as possible so that the greedy do not take too much. But this is mere rationing; it is not production of food. Inefficient administration also reduces the supply of food and encourages hoarding and at times Government also begins to hoard which ultimately results in the grain being damaged and spoiled by insects. The Entomologists will give you a report about the damage caused by the insects to grains. In fact insects are our enemies. They are our terrible enemies and have done us more damage than the Germans and the Japs. Insect world is the most terrible enemy of mankind or mankind is the most terrible enemy of the insects. Insects are perhaps the worst enemy of mankind, not only in the matter of resources but even in the matter of growth and production also. We have to kill insects in order to preserve our produce in good condition.

Let me tell you, there is no difference between the vegeterians and the non-vegeterians. Truly speaking, the vegeterians kill more animals than the non-vegeterians. In order to produce a fruit you have to kill more animal lives — insects, than my non-vegeterian friend who is content with one large bit of animal life. If we wish to produce food in good condition we have to kill insects. All that, you are studying, I think. I have only got a vague notion. I know that from orthodox kisans who thought themselves to be very pure. They had a few coconut gardens. I enquired how they grew

them and they described to me how they took out the beetles and killed them with a spike.

As I told you in the beginning, there is a very fine spirit in your college, stronger than in other colleges. But it is not quite enough to be better than the other colleges. I am told that you are a very strong batch, and may you be preserved for long. It is a good thing to be united, to have plenty of animal spirit and to be happy and cheerful and not demure, but you must be disciplined. After listening to me this year there will, I hope, be a marked improvement in the discipline, cheerful and joyful obedience, which is more akin to co-operation than obedience. I hope there will be more of it next year and that I hear about it somehow or the other. I congratulate you all on the work that you have done.

I am very glad to notice in Nagpur that the student secretaries take upon themselves, with perfect confidence, the responsibilities of the college. They describe the whole administration, when they read the reports, as if they have conducted it themselves. This, I think, is a very good thing. It is an important part of the education. That is what I begin to think after coming to Nagpur and noticing this. The teachers do well and the Government also does very well in making the student secretaries and presidents of unions to feel that the college is theirs, that the administration is theirs; that if a teacher does well it is the student that should congratulate; if a teacher does ill, it is the student that should make no reference to it. A spirit of responsibility is cultivated by it which is therefore important to education, in my humble opinion, and I must tell everywhere I go to other Provinces, the experience I gained here. I must tell my student friends in my own Province how the students in Nagpur consider themselves responsible for the entire work of the college and the Principal allows them to read the report, and in fact, Mr. Churchill might send a copy of this report to Government, with very few changes. In my opinion, it is a very good thing and it should be encouraged.

I already told you, friends, that I do not know anything about agriculture, but I have heard the name a long time back — a good long time ago. I have in my own part of the country agricultural colleges and some of them are older than some of the colleges of these days. Even here I understand that your college is a very old one, older than the University anyway. Very soon you will qualify for your Golden Jubilee. You will be 50 years' old very soon, and it is all right.

Agriculture is our chief industry in India. It is our chief mainstay in India. The colleges are new but agriculture is very old. A college for agriculture is an institution of modern times set up by the present Government. European civilised Government has brought into existence this special institution called the College for Agriculture. When you take your degree, while other people are simple B. As. or B. Scs. and so on, you are B. Sc. (Agr.), and you look more terrible. You have got all things. Well educated boys as you are, after your absence from the college, after you get the degree and leave the college, your first duty is to help the man at the plough—*the real man at the plough.*

Now, this is apt to be forgotten, on account, first of all, of the difference in the medium of instruction. The man at the plough talks a different language. If you go and tell him what you have learned he will not be able to follow you. There is a difference of language which divides you from the man whom you have to tell what you have achieved. This is not the only difference. Your training makes you feel different from him. You have dressed in a peculiar fashion so that he thinks that you have come to tax him instead of helping him. He thinks that you are a *sahib*. He gets frightened by your dress, by your nature, and believe me, even by your manners of behaving with him. All these are obstructions in the way of the attainment of your goal which is to help the man at the plough — *the real cultivator.* All these difficulties arise as a result of your education You have therefore to go into the villages and learn agriculture by yourselves. Then only you will be of great help to the peasants. But if you come to the Nagpur Agricultural College and go back to the village you create a new language for yourself, for your manners, etc. New difficulties arise for yourselves and when you try to help the peasants, the peasants after hearing you will go to the local agricultural prophet and make sure whether what you say is right or wrong. If he says yes, then you have passed. Remember that the final diploma holder is still in the villages. If he gives you a bad character you will be lost.

You must cultivate the friendship of the local peasants if you wish to help the peasants. This is what I can think as a politician. I think, as a politician, I should advise all agricultural administrators to cultivate the friendship of agricultural peasants, may be money-lender, official, priest, school master. But it is better to cultivate friendship if you want to get across to the peasant. This is the main order to help the peasant. How shall we reduce these difficulties and make the passage of our learning easier to get across to the peasants? We must try as far as possible, to

familiarise ourselves with the language of the peasants. You must know the characteristics of wheat, cotton, sugarcane, etc., which have been growing in our country for many years past, through foreign language as you are doing now. You have to learn all about it again through the language of the peasants and try to get yourselves in touch with the language they speak. When you go to the villages, at least try to pronounce all these articles in the local language, which is cotton, wheat etc. Use the local names of wheat, maize, cotton and the like. We have in my part of the country a language called '*Tamil*'. Now even in that part of the country where 3 crores of people speak this language, people use the word 'water' for water. That is a serious difficulty of language. So if you wish to help the peasants, try to speak their local language. This is a very important piece of advice which a layman like me would like to give you. The problem of language should be remembered when you deal with your real friend, viz., the peasant.

There is also a very important element which I should like to refer to you, viz., the attitude of humility towards the peasant. Because you get a degree do not imagine that you know more than the peasant. You really do not; you know less than the peasants. Therefore let us be humble. May be, we have tried to learn more things. You have yet to learn what the peasant has learned. When therefore you finish your studies and take your degree, do not imagine that you know more than the peasant does. In fact, you have to know a great deal. If you develop an attitude of humility towards the cultivator, then at once all your learning gets a new colour and a new realness. The very thing is transformed. The learning that you have got becomes more useful, if you develop this attitude of humility towards the cultivator. But otherwise it is just like a dry biscuit as compared to a real hot meal. Your learning is something like that biscuit that comes in tinned boxes from England. It has nothing to do in this country. All your learning has come in books from England. Of course, in the college it is all made into life. In the colleges it is again converted into the living material with vitamins. The dry books receive their vitamins in the course of teaching in the college and in the course of their application to the soil conditions of this country.

Then again, you have to go to the field and apply your agricultural knowledge there. What generally happens, as far as possible, is that the graduates in agriculture seek employment in the Agriculture Department. They do not think anything beyond that. While our educational work becomes a kind of self-assistant organisation, more places have to be invented by Advisers in order to supply employment to all agricultural graduates. They do not

go to the farms. They get into the Agricultural Departments. This is also necessary. But that is not enough. We must man the department well, we must man the colleges well, but nothing is yet done. We must give the cultivators the benefit of our learning, teach them new methods of producing increased crops. We must go to the countryside to produce more. Our learning must be adapted to the conditions of our country.

I have talked as if I knew all about agriculture. But really I know very little, as I told you. What is wanted is agricultural wealth. To attend to this is your primary aim. You must make it your occupation. By helping the peasants in the country a great deal may be done. I know that a great deal can be done because as I did tell you I have heard about this for a good long time. My father was a very good agriculturist. He was a poor man. He was not a peasant by caste. There is nothing in our country without caste; everything goes by caste. Really, agriculture is a caste in our country. My father was not a caste agriculturist. He was a priest brahmin, and he, however, was a great agriculturist. And I was born in his house and heard about it from my childhood. In fact, things look bigger in childhood than they really are. He used to take me to the field and showed me the business there, and I used to see it all. It was my college. Your training is in a different way and I know only from what I knew only in that manner - *Agriculture from the field*. But it has impressed on me a permanent feeling of respect towards the villager, towards the field, towards the peasant, towards the poor cow whom we do not give enough comforts, towards the bullock whom we do not even wash properly, towards the implements used in the field. I have got that feeling and I want to impress on you that feeling on this occasion. During this half an hour I want to give you that respect so that you will have the humility that I give you when you go to the villager. I do not think that each one of you will get the same experience that I have got. But you can get the same experience if you try a little, provided you behave in a humble manner.

That much can be done has been proved to me recently. I had a Minister for Public Health. He was a good surgeon and a very successful surgeon in my part of the country having London degrees also, and he became a Minister for Public Health when I was able to select my ministers. I thought that he was a doctor and a surgeon, and would put right the Department. But it was a mistake. My experience is that it is no good putting a man to that department to which he belongs. A minister for Public Health becomes a Surgeon General or an Inspector General, and then there

is friction. I do not mean that Dr. Rajan was unsuccessful as a minister for Public Health. What I want, to tell you is that if you take a doctor politician do not put him in charge of public health, if you get a school master politician do not put him in charge of education; put him in charge of jails, and so on. This is the general policy that should be adopted. Dr. Rajan was a very good minister for public health.

We all left our offices, as you know, 5 years ago and then he went away to his place, to his farm. He wound up all his clinic, wound up his politics, wound up his public activities and now he is a simple agricultural farmer on his farm—not a B. Sc. (Agr.) as you are. But I tell you he has produced five times the quantity of rice that had been produced before his time on the same farm. I do not think he ever related to me anything with so much delight as the fact of his being able to produce more rice. He takes more pride in having more rice than formerly had been produced. Only the other day he was telling me how successful he had been as an agriculturist. If you have a will, you will also be able to do the same thing, and if you have extra knowledge and energy, surely you will be able to do it. He has secured prizes from the Agriculture Department for having produced more, and he wrote to me all about it with great satisfaction saying that he has been successful. This has proved to me that if we exert, if we put sincere effort in the task, we can produce more than we were able to produce in the same piece of land.

Now-a-days it is fashionable to hear one saying that "I am growing such and such things in my garden". It is a very good thing, I tell you. It is a kind of nostalgia, which means an affection for one's own urge towards one's own birth place. Everybody when he is old, wishes to go back to the place where he was born. He likes to get back to the old surroundings. If you raise a little bed of cauliflower in your own land, you will feel much delight as much as your first child was born. If you get a rose out of a plant which you have watched and watched growing, there is nothing, and then you see a flower, you feel a joy which is as the mothers feel when they get their first child. It is part of our nature. We go back to the place where we were born, *i. e.*, the land out of which we came and we find pleasure in producing food from our own land.

Now this is nothing new. It is described in the oldest scriptures of our country. In fact, our ancient philosophers have described food by the name of the Supreme Being itself. They call food '*Brahman*' and *Brahman* means food. They say, "What is *Brahman*" ? It is the *Universal Truth* in one sense and the

Producer in the other sense. He creates before your eyes. What is this ? It is that which creates food; it is that which creates you. You eat food, produce energy, life, children etc. It is the food that produces all this. That is why food is *Brahman* in the other sense of the term. Therefore do not look down upon food. If you go to a friend's house, eat something there, do not say it is not good. Praise the food, appreciate the food that you have eaten. Produce food they say.

Now they try to produce new literature on the subject which does not carry conviction. You may think that the "Grow More Food" is a new invention. But I tell you that it is not a new thing. It is in the Upanishads. I can quote you here. They say produce food because food is *Brahman* and at the same time they ask you to produce more and more of food. There is a cycle that is thoroughly described in the Upanishadas. *Brahman* produces food, food produces man, man takes the food, man becomes food. All those that absorb food become again food for something else. This is the change of the Universal organisation. Organic life in this world is arranged like that. Each is a food of something else. That is a complete cycle. You produce a little rice, you eat it. You grow, it gets into your blood and gets into your body The report that you have read and written is read and written up by the food you eat. It is the food that is speaking and listening.

Again, when you die you go into the earth. You become food for some worms. If you are careless, you become food for some germs even while you are alive. What happens when a dog dies. You bury it somewhere. It gets into the earth which you apply to the oranges and other fruits, so that it gets into the orange and the orange becomes it and when you eat the orange you really eat the late dog in a different form. You analyse things in this way and you will find the truth of what the Upanishads have said.

All things convert into the earth ultimately, and again into the food. Our earth is very good in all respects in that it takes all rejected things and produces good things such as food and fruits for you. Are you half as good as the earth ? It produces grass which is eaten by the bullocks. Supposing we do not give our bodies to the earth but burn them Still that makes no difference. After all, what is burning ? The ash goes into the earth and the gas into the atmosphere. Whatever may be the custom of cremation followed, you go back to the earth. It is a complete circle like that. Each thing is food for the next thing. Such being the relative truth, our ancestors have stated in the

Upanishads "Produce more food; do not degrade it, respect it, as if it were God in itself".

Now, the Agriculture College should have that as a motto The Grow More Food propaganda was done by our people thousands of years ago. Therefore I say that the college is important not only for the duration of the War but also for ever. Mr. Churchill may say that the Adviser is responsible not only for development but also for finance and food. So the Adviser is *Brahman* here and so Mr. Churchill may say to the Adviser, "give us more finance, do not wait for the end of the war". Agriculture is the best fighter in the war, it is the best regiment in the war. Agriculture Colleges are fighting as soldiers". And you students must appreciate whatever Mr. Churchill says because you will have more funds.

Our country like your Agricultural College depends a great deal on the strength of numbers. Do you know why England has some respect for India, not because you have learnt English. Do not think in that term. Do not make that mistake. It does not carry much. It is our number that they respect. We are 40 crores of people. They get frightened when they think about that. And it is good that we must have our number increased. Do not believe people who want to reduce the number of births. I tell you, it is a great mistake to think in that term. If you do that mistake of reducing the population, you will go down in this world. As you must increase food, you must also increase the population. Do not reduce it. If I am heard by a true British Imperialis there he may take my saying so too inflammatory. But I think your Adviser who is here is not a true Imperialist and he won't take it too inflammatory. There is quite a large amount of knowledge that is awaiting to make more out of the 10 or 12 inches of earth. We can produce a great deal and we can produce more food and not reduce population. The reduction theory is a selfish theory; not a national theory. Each individual wants to live in comfort. He wants to live more comfortably than other people in this country. He wants to be more happy and prosperous than his neighbours. Therefore he wants to reduce children—not a good proposition. It is a selfish proposition and therefore there is nothing great in it. Therefore produce more food to have more men and women in our country, so that we can afford a war or two.

Look at the trouble in Europe now. Best men are killed. All the fighting men are killed. Only the oldest remain behind. One says he has lost his son, the other says my other son is a prisoner of war and so on. Whereas we—10 children in a family! If 2 of

them go, 8 still remain. It is good to have a good number of children but it is no good to have a bad economic system. We should have more children, we should have more food and we should have more energy to produce more as well.

Thank you for listening to my rambling talk. I wish you all success. I congratulate all the prize winners once again. I congratulate the College. The prize winners are only a few in number, but I find here that all the prizes are enjoyed by all the boys. It is no good unless you have inter-college prizes. Take interest in your own college. I congratulate you all and hope that you will keep up your animal spirit and win more prizes in your life as you have done now.

Some Physical Properties of the Soils of Nagpur

by

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Introduction:—It is on the physical conditions of a soil that its chemical and biological activities are dependent. A most fertile soil will fail to produce any crop if its physical conditions are not favourable for the intake and outflow of water, movement of soil air and the important activities of the soil bacteria. These factors are directly related to its pore space, maximum water holding capacity, swelling and shrinkage and the upward and downward movements of water. A preliminary study of these properties in the important soils of Nagpur has been made in course of the last three years and some important results are discussed below.

Nagpur is situated at 21° - 10′ N and 79° - 5′ E at an elevation of 1025 feet with an average annual rainfall of 50″. The city is built on a confluence of two types of geological formations - *The Traps and the Crystallines*. The trap hills which constitute the main features of the Deccan Plateau are seen overlapping the underlying sandstones and gneisses in this area. The soils are, therefore, derived from the trap rocks on one side and the silty deposits of alluvium on the other.

The soils of Nagpur may be grouped according to their position and formation in the following categories :—

I. *The Red Soils* on the tops and slopes of the trap hills occupying about 5% of the cultivated area. They are commonly termed as *Bardi* Soils. The main characteristics of these soils are the predominance of grit, gravel and pebbles or stones derived from the central cores of concretionary trap rocks. The depth of the soil varies from a few inches to a foot or so depending upon its position. These soils originate from the *in situ* decomposition of trap rocks which are subjected to severe leaching and washing. Iron and alumina are left behind while the other constituents, the basic materials of the trap, are washed down. These soils are ordinarily unproductive, supporting only poor types of grasses and short duration rainy weather crops when brought under cultivation.

II. The light coloured *Khardi* soils on gentler slopes of hills or near the foot of hills, which occupy about 27% of the cultivated area. These are shallow soils with plenty of sand, kankar and gravel. These soils are the result of *in situ* decomposi-

tion of concretionary, vesicular, or felsitic types ot traps, but are not subjected to the same degree of leaching or washing as the *Bardi* on account of their gentler slope. The depth varies from 6" to 18" with an underlying partially decomposed parent rock. These soils are fairly amenable to cultivation and a large variety of crops of short duration are grown on them.

III. The *Morand* or the Black cotton soil is the most predominant type of the soils found round about Nagpur. The colour varies from slaty grey to dark grey. The black colour is not on account of the organic matter it contains, but is derived from the titaniferous silicates resulting from the decomposition of trap rocks. The black soil is found covering large expanses of land, even on the table lands which are not exposed to severe leaching. This soil covers, in a layer of 6" to 3' or more, the yellow murum and the parent rock lying below it. It is a very productive soil growing a number of rainy weather and winter crops like Cotton, Juar, Tur, Wheat and Oilseeds. The more clayey grades are known are *Kali* soils, but the area under such soils is very small. The remarkable feature of the black cotton soil is its immense swelling on wetting and a striking shrinkage on drying, resulting in self pulverisation in winter and development of big cracks in summer.

IV. The yellow clayey soil, the *Chopan*. This soil generally underlies the black cotton soil in a layer of varying thickness and sometimes appearing on the surface mixed with pebbles and grit. The genesis of this soil may be described as the washing down of clay particles from the overlying or highlying black cotton soils through their cracks and accumulating over some impervious layer. This itself forms a clay pan. Being very sticky and impervious, the soil has very deleterious effects on the drainage of the overlying black cotton soil and the crops growing on it.

V. The *Silt* is found only in beds of tanks and on river and nallah sides. This is again of light dark shade without the characteristics of *Morand*. The soil is productive and can grow any type of irrigated or non-irrigated crops.

The textural make-up of these soils as given in Table I wil be seen to be a great factor in the determination of their physical properties. The *Bardi* soil though containing a high percentage of clay, can on account of its shallow depth and predominance of pebbles and boulders, be grouped under coarse gravelly or sandy loam. The silt is *Silty* loam, *Morand*, *Clay* loam and *Chopan*, hard clay.

TABLE I.

Soils.	% sand	% silt.	% clay.	% $CaCO_3$	Remarks.
Sand ...	95	....	...	....	Kanhan river sand
Bardi ..	27·3	18	45 75	0·2	(Bal)(1)
Silt ..	22	42	36	...	
Morand	8·6	27·3	44·8	0·7	(Bal)(1)
Chopan ...	33·3*	15 0	50 0	..	*includes fine gravel.

The structural conditions :—The arrangement of the particles in ***Morand*** soil is always towards granulation on account of its alternate swelling or shrinkage which results in self ploughing, unless puddled by inadvertent soil management. The ***Chopan*** soil, on the other hand, always proves to be compact or puddled giving a water-logged conditions in the rainy weather. The ***Silt*** and ***Bardi*** are open stiuctured soils providing good drainage and aeration. These properties are borne out by their percentages of pore space and App. specific gravity given in Table II.

Swelling and shrinkage :—The properties of swelling and shrinkage are governed by the clay constituents (textural factor), the amount of organic matter and colloids, also by the amount of packing given to the soil samples, and their moisture absorbing capacity.

The degree of swelling in different soils was measured taking air dry soils passed through 2 mm sieve and uniformly compacted. The results obtained are very interesting, the ***Morand*** soil has given the highest percentage of swelling followed by ***Chopan***, ***Silt***, ***Bardi*** and ***Sand*** in order of their clay and humus contents.

This high percentage of swelling and a consequent close packing of particles in ***Chopan*** explains why the soil (***Chopan***) becomes impervious to water on wetting resulting in water-logged conditions in the fields. The small swelling in sands and silt does not destroy their porosity and the soils are thus naturally drained of excess of water.

The shrinkage in these soils was compared by making bricks of uniform sizes of uniformly puddled and compacted samples. The reduction in volume after drying for the same length of time has been measured. The results are again quite parallel to their clay, humus and sand ingredients. The highest percentage of skrinkage is observed in *Chopan*, followed by *Morand*, *Silt*, *Bardi* and *Sand*. The greater the percentage of clay or colloids, the greater will be the cohesiveness and plasticity which cause the soil particles to draw closer together when the moisture from the pore spaces is receding.

It has been observed that the addition of cattle dung manure to *Morand* increases its swelling, but reduces its shrinkage while sand reduces its swelling as well as shrinkage, which may account for smaller cracks in well manured fields or sandy oils.

The coefficient of shrinkage and swelling in these soils obtained by dividing the shrinkage by swelling, is the greatest in *Chopan*, followed by *Morand*, *Silt*, *Bardi* and *Sand*. The soil shrinks to a greater degree than its swelling, by alternate drying and wetting and, therefore, cracks are formed in it. The high shrinkage-swelling ratio in the black cotton soil accompanied by a higher shrinkage in its subsoil *Chopan*, where it occurs, explains the self-ploughing or self pulverisation of these soils, resulting in cracks which are from a fraction of an inch to about a foot in width and from a few inches to several feet in depth.

Cohesiveness :—A comparative study of the cohesiveness of these soils was made by rupturing dried bricks under a rupturing knife edge, the weight being applied at 12″ from the centre of the bricks and at 18″ from the fulcrum. It is observed that highest pressure was needed to crack the *Chopan* soil, followed by *Morand*, *Silt* and *Bardi* in order. Addition of 50% farm yard manure to *Morand* increased its cohesiveness, while 50% sand mixed with it, decreased this property. The high crushing strength in *Chopan* and *Morand* may therefore be attributed to their clay and colloidal contents.

Movement of soil water:—The downward movement of water in these soils was observed in columns of 6″, uniformly compacted on a compacting machine. Sand required the smallest time, about 108 seconds to percolate through a column of 6″, whereas *Bardi*, *Silt*, and *Morand* took 13, 36, & 106 minutes respectively. *Chopan* required about 21 days to sink down to a

depth of 6", but actual dripping of water was not set up even after that which is on account of its minute clay particles swelling and filling up all interstitial spaces *Chopan*, therefore, is the worst soil occuring as subsoil in some localities, where heavy showers of rain cause waterlogged conditions. This property of the soil is taken advantage of, in some parts of Berar, where the tops of open terraces of houses are plastered with *Chopan* to make them waterproof.

The high percentage of lime in *Morand* counteracts the tendency to waterlog. The soil becomes traversed with a network of minute cracks on account of the flocculation of clay particles just a few hours after a shower of rain. This is why even after a shower of 2", the *morand* soil becomes workable with implements within the next 24 hours of clear weather. This is not possible even in light soils of other descriptions in the Province *e.g. Bhata, Matasi* or *Sehar.* Addition of organic manure and sand was found to facilitate percolation of water. (vide Table III).

Upward movement of water.—The upward movement of water takes place in all types of soils. This may not be a process of capillarity according to Dr. Keen, but only a phenomenl of the filling and emptying of the cells made of interstitial spaces on account of pressure deficiency in them.

Uniformly packed soils in 24" glass tubes were kept over water troughs and the rise of water was observed from time to time. It is found to vary with the clay, sand and humus content of the soils. In case of sand the rise was quick to start with, reaching a height of 7" within an hour while it stopped at 10.5" even after several weeks. This may be due to the interstitial spaces not being sufficiently small or close together to allow greater curvature of the water film to develop greater pressure deficiency or suction force which controls the filling or emtying of the cells. In case of *Silt* and *Bardi*, the water reached the top within 14 days. *Morand* was slow but steady, and this height of 24" was reached in 24 days. *Chopan* was the slowest, even after 100 days the water could not rise beyond 12", whereas in case of sand it was 15" even after 120 days.

Water holding capacity:—The maximum capillary capacity or in other words the water holding capacity of these soils was measured taking 2" of the soil columns of uniform compactness. The results obtained confirm the relationship between the pore-spaces, texture and organic matter and the capacity to which water can be retained by the soils. The highest amount of water

was retained by *Chopan*, then by *Morand*, *Silt*, *Bardi* and *Sand* respectively. Addition of 50% organic manure to Morand increases its water holding, capacity while addition of 50% of sand is found to reduce it.

__Summary__

(i) The physical properties, *viz.* Ap. Sp. Gravity, pore space, swelling, shrinkage, cohesiveness, percolation and capillary rise of water and the maximum capillary capacity of the soils of Nagpur have been investigated.

(ii) It has been observed in all cases that these properties are directly related to the texture of the soil *i.e.* its sand or clay constituents. The finer the soil, the greater are the percentages of pore-space, swelling, shrinkage, cohesiveness and the water holding capacity, while lower is the Ap. Sp. Gravity and slower are the downward and upward movements of water.

(iii) Farm yard manure when mixed with *Morand* has been found to lower the Ap. Sp. gravity, facilitate the upward and downward movements of water, reduce its shrinkage and swelling, increase its maximum water holding capacity and the cohesiveness.

(iv) River sand when added to *Morand* has been observed to increase its App. Sp. gravity, facilitate the downward movement of water, and reduce the swelling, shrinkage, maximum water holding capacity and cohesiveness and the upward movement of water.

(v) From the point of crop production and ease in cultivation and management of the soil, *Silt* would be the best, while *Morand* with its high calcium content and self ploughing properties comes the next. *Bardi*, on account of its position and shallowness, does not hold much chance of being considered as a good soil, though its productiveness, with good supply of water, cannot be ignored. The *Chopan* is decidedly the worst soil for crop production. In fact, *Chopan* has been found by Joshi[7], Vaidya and Ingle to produce dileterious effects on crops as their roots instead of penetrating the *Chopan* layer were seen to curl upward and form a mesh.

(vi) The value of addition of organic manures and sand to clayey soils like *Morand* has been well borne out by the above improvements in the physical properties of soils.

TABLE II.

Soils (Uniformly compacted laboratory samples).	% pore-space by Vol. (uniformly compressed.)	App. Sp. Gr.	% Swelling (air dry fine earth.)	% Shrinkage.	Shrinkage Swelling Ratio	Cohesiveness (wt. required to rupture the bricks.)
1	2	3	4	5	6	7
1. *Sand.*	40.52	1.454	1.7	1.5	0.8	....
2. *Bardi.*	52.27	1.260	3.90	14.7	3.8	16.81 lbs.
3. *Silt.*	63.74	0.996	6.06	28.57	4.7	25.52 „
4. *Morand.*	59.78	1.097	14.17	43.51	3.0	5.82 „
5. *Morand* + 50% Manure.	66.5	0.78	15.89	37.65	2.4	77.67 „
6. *Morand* + 50% Sand.	44.8	1.313	11.50	21.09	1.8	38.34 „
7. *Chopan.*	70.0	1.154	11.07	47.22	4.3	92.12 „

TABLE III.

Soils.	Time for percolation.			Capillary rise in inches.					Maximum Water holding capacity by wt.	Remarks.
	2″	4″	6″	1 hr.	1 day	7 days	14 days	21 days		
	m. sec.	m. sec.	m. sec.							
Sand.	0-30	1—5	1-48	7″	9″	10″	10.5″	10.5″§	24.19	§15″ in 120 days.
Bardi.	2-12	6-10	12-55	5″	10″	20″	24″	....	34.63	
Silt.	3—0	15-45	36-25	6″	18″	22″	24″	....	51.03	
Morand.	7-20	39—0	105-40	2″	4″	9″	15″	23″ *	50.73	*24″ in 24 days.
Morand + 50% Manure.	2-48	7-36	17-57	3″	5″	12″	16″	24″	56.0	
Morand + 50% sand	2—3	6-54	17-54	3″	8″	10″	14″	21″	36.31	
Chopan.	9 hr.	48 hrs.	21 days	1″	2″	5″	6″	9″ †	76.07	†12″ in 100 days.

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A brief Survey of Agriculture in the Hyderabad State

by

M A. RAHIM, Inamdar, (I year).

Any subject concerned with agriculture of a region needs no formal prelude, save a bird's eye-view of its grographical conditions. Hyderabad, on account of its area and material wealth, stands first and foremost amongst all other native states of India. In its sustained prosperity it has been and is a source of envy to its sister states. This prime state, triangular in shape is situated below the Vindhya and Satpura hills, almost in the middle of the peninsula, and the Eastern and Western ghats embracing it on both sides. Being a tableland, it is considerably high above the sea level.

Rains and irrigation :—Its geographical situation as stated above, is such that it falls in the monsoon belt. The South-west monsoons which form a major factor of rainy season in India, rising from the Arabian Ocean blow, right across this state, making it abundantly rich in rainfall. The rains set in from the first week of June, and come to a close by the last week of. September thus covering a period of about four months. These early rains after wetting the parching throat of the soil, which had just fared with the immediately preceding burning season, lend it aptness for sowing the Kharif crops. These crops later on continue their growth throughout this season. Very often germination, in this State fails due to either excessive rainfall or the scantiness of the same. In such cases resowing process is resorted to. The winter showers of the North-east monsoons are greatly helpful to the rabi crops, as, from time to time, they quench the thirst of the plants which cannot be wholely dependent upon the soil moisture retained from the early rains, commencing after the summer.

Rainfall in almost all parts of the State is uniform despite one or two districts such as Raichur and Bedar, which unfortunately fall slightly away from the monsoon zones. In fact Raichur is the only district which suffers from deficient rainfall and hence at times, famine is feared here. But the Government of Hyderabad is liberally and aptly exerting its best in every way to make up for this shortage by the development of irrigation systems. The question of utilizing the waters of the Tungabhadra and Krishna, for irrigation purposes in this district, is under consideration. Thus the State is canalising all its best efforts in this respect, which happens to be one of the most

nerve-testing problems that the State is to face to-day. Simultaneously, adequate attention is being paid to the plan of extending this irrigation development to other districts too. Adilabad, Karimnagar, and Nizamabad are the districts of comparatively heavy rainfall.

The Nizamsagar dam, is the masterpiece and epoch-making construction of the present august ruler of Hyderabad. Its name signifying his dynasty, will ever shine with undimmed lustre accross the pages of the history of monumental constructions of his reign. In its area and its estimated life this dam stands third in India. To-day, it is irrigating thousands of acres of land turning it into wet-crop soil, which was previously not under cultivation. This dam is an unfailing fountain of bliss and agricultural prosperity for the State, which the Government of Hyderabad can justly be proud of. In remoter areas cultivators temporarily dig canals in rainy season, so as to allow rain waters, the waters of small tanks, kuntas and streams to run in to their fields. Kuntas, this being the vernacular name for small stocks of rain water are very common in Tellangana districts. This system of water supply is termed as the small scale irrigation system.

Soils and crops :—On the basis of the nature of soil the Dominions are mainly divided into two tracts, what are known in the vernacular as "Simt", one of them being the Marhatwadi Simt and the other Tellangana Simt.

The soil of Marhatwadi Simt is black and at some places brown, called in vernacular as Bhoori, specially suited for juar and cotton crops, the latter being the main crop of some districts in this Simt. Bajra, ground nut, tuar, ambada and cotton are the main crops in Kharif, and wheat, gram juar and kusumba or karad being the main crops in Rabi. All these crops come under the category of dry crops, so called because of the fact that they are partially dependent upon rains, being independent of any other water supply. Thus Marhatwadi is a dry crop tract.

On the other hand the soil of Tellangana is composed of clay and sand, the latter making a very little percentage and the former being the prime-factor of the soil. This semisandy soil as is its nature, is best suited to the paddy crop, and therefore the main crop of this Simt is paddy which is the common diet of the natives of this tract. Paddy with inclusion of some other crops consisting of pulses, oilseeds and cereals comes under the category of wet crop, meaning thereby, crops which are dependent upon artificial water supplies in addition to rains.

Sugarcane:—In addition to these seasonal crops, sugarcane is accelerating its growth to an extent which will enable it to be deservingly included in the main crops of this tract. It is irrigated with the water of the Nizamsagar dam. But for the existence of this dam the Dominions would have run the risk of being in absence of this crop. The area under its cultivation is being increased day by day. The benevolent sovereign of Hyderabad seems to be particularly interested in it as his Government has invested largely in the Bodhan Sugar Factory. The sugar obtained from this factory is consumed in the Dominion. It may reasonably be expected that the factory may have a production enough to spare for exports. To-day this sugarcane improvement is being made on the most up-to-date scientific methods with experienced and well-versed scientists to guide, and thus tends to form an initiative of utmost importance in the agricultural development of Hyderabad and the State deserves all praise for undertaking this agricultural enterprise.

A peep in the percentages of different productions will clearly indicate that the state is self sufficing in its food necessities and is self-dependent in its raw material for home industry. That is why, to-day, when India is passing through a critical situation of food shortage and when most of the States and Provinces are being faced with problems arising out of it, Hyderabad is relatively better provided with her own produce.

TABLE I.

A statement showing the area under juar and its production in various provinces in India, in comparison with those of the State.

Province or State,	Area in million acres,	% of total area under juar in India,	Production in hundred thousand tons,	% of production of juar in India,
1. Hyderabad	8.51	24.93	13.03	19.9
2. Madras	4.96	14.52	12.62	19.28
3. C. P. & Berar	4.45	13.05	10.02	15.3
4. Baroda	0.66	1.98	1.01	1.54
5. Mysore	0.65	1.92	1.24	1.9
6. Sind	0.43	1.23	0.95	1.46

TABLE II.

A statement showing the area under cotton and its production in some important cotton growing tracts.

Province or State,	Area in hundred thousand acres.	% of area under cotton in India.	Production in 1000 bales of 400 lbs. each.	% of production of cotton in India.
1. Bombay	57.41	25.1	1139	21.7
2. Punjab	36.38	14.4	1372.0	26.2
3. Hyderabad	32.52	13.8	512.0	9.8
4. Baroda	8.26	3.5	67.4	3.2
5. Gwalior	6.4	2.6	105.2	2.0

TABLE III.

A statement showing the area under gram and its production in some important Provinces in India compared with those of Hyderabad.

Province or State	Area in million acres	% of area under gram in India	Production in hundred thousand tons.	% of production of gram in India.
1. U. P.	5.76	37.5	2.8	36.2
2. Bihar	1.38	9.0	4.32	12.1
3. Hyderabad	1.25	8.1	2.00	5.6
4 C. P. & Berar	1.14	7.4	2.09	5.9
5. Mysore	0.80	5.2	0.69	1.9

TABLE IV.

A table showing the area under groundnut and its production in some important provinces of India in comparision with those of Hyderabad.

Province or State.	Area in million acres.	% of area under groundnut in India.	Production in 100 thousand tons (nuts in shell).	% of groundnut production in India.
1. Madras	3.61	48.23	16.51	56.16
2. Hyderabad	1.33	17.74	4.22	14.35
3. C. P. & Berar	0.20	2.7	0.55	1.88
4. Mysore	0.20	2.70	0.38	1.29

TABLE V.

A statement showing the yield per acre of raw sugar in some important provinces in India with reference to that of Hyderabad.

Province or State.	Yield in Tons per acre.	Province or State.	Yield in Tons per acre.
1. Baroda	3.63	4. Mysore	1.54
2. Bombay	2.40	5. C. P. & Berar	1.47
3. Hyderabad	2.17	6. Punjab	0.79

From the tables above, it is quite obvious that juar crop stands first in rank and others follow it in successive order. With regard to these crops with the exception of juar, the State, as the tables above indicate, occupies a moderate position, neither being abundantly rich nor desperately poor.

Other products:—Dairying in the State is still in its infancy, same being the case with Veterinary as such hospitals can be counted on finger tips and these too are centred in big towns, remote from the rural area where they are most urgently needed. Cattle breeding is progressing with rapid strides. Hingoli taluq due to its suitable climatic conditions for cattle breeding, has been selected as the centre for the purpose. Moreover the ruralfolk, here, exhibit native aptitude in this respect. At cattle exhibitions, prizes are awarded to those who are in possession of healthy cattle and bullocks of high breed, thus providing ample scope for greater improvement. Cross breeding system is not yet prevalent. Crop exhibitions are annually held for popularizing improved seeds, and improved implements. The State is supplying good seeds free of charge to make the farmers realize the importance of seed quality, and the better results which follow. They are liberally giving taccavi loans and loans from Co-operative Societies at very low rates of interest, and payable in convenient instalments, thus freeing them from the grip of money-lenders.

Himayat Sagar Farm needs its mention in this connection, Here moderately educated youths are trained in elementary knowlege of farming and after the completion of the course, are awarded Diplomas. It is regrettable to state that even to-day, many are not interested in agricultural activities assisted by science. Nevertheless the increasing number of State scholars studying at different Agriculture Colleges bears testimony to the fact that general interest has been roused in them.

"Agriculture is the backbone of India" and hence she cannot ever dream of prosperity without developing the physical, mental, intellectual and social state of her teeming millions. The man behind the plough needs the fostering care which aims at attaining for him a worthy position.

"Happy the man whose wish and care
A few paternal acres bound
Content to breathe his nature air
in his own ground."

Heat in Controlling Seed-Borne Diseases of Plants.

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The application of heat or temperature in the art of controlling plant diseases is a new practice dating back from the early 'eighties of the last century'. Prior to this efforts at controlling and curing diseases in plant were directed along such sanitary and hygienic operations as rogueing of diseased plants, eradication of alternate host-plants near about the fields, rotation of crops, regulation of drainage, application of lime or fertilizers to the soil, propagation of disease-free stocks, seeds and setts or along such direct control measures as seed dressings and spraying (or dusting) of fields and plantations with appropriate fungicides known at the time.

But the discovery of the therapeutic value of heat in the science of plant pathology and its successful application thereto was made by the Danish School-master and agriculturist Jens Ludwig Jensen Working with the 'Late-blight' disease (Phytopthora infestans) of potato, Jensen (1882) found that none of the control measures known at the time was effective enough to check the rot caused by the disease. But he achieved at the same time a momentous success to be able to discover that the fungus of the 'late blight' disease lives in a dormant way within the body of the tuber itself and that the disease manifests itself in the progenies when such tubers are net used for sowing or sets in rots when kept in storage for future consumption. This finding of the occurrence of the 'germ' of the disease deep within the tissues of the tuber had far-reaching consequences on the next course of his investigation. It dictated to him that surface sterlization of potato tubers with dusts or fungicides would be of no avail as the fungicide could not get in to affect the 'germ' living inside. And this set him to think how the internal dormant 'germ' (i. e. fungus) of the disease could be killed without impairing the vitality of the tuber.

Happily, it was known to him that (6) all organisms could be killed by heat and (2) this lethal temperature (*i. e.* the temperature that kills an organism) varied according to the organism that was sought to be killed. So, acting on this principle he first determined the lethal or death point temperature for the 'Late blight' fungus as well as that of the seed potato tubers and found that a temperature of 40° C would kill the fungus within the potato tubers while a higher degree of temperature was necessary to cause the loss of viability of the potato tuber. So here Jensen got a thing which could penetrate in and destroy the fungal germ without killing the

tuber itself because, as stated earlier, this temperature was much lower than that which would cause death of the potato tubers. He therefore, treated the seed potatoes in water at 40°C for 4 hours; this completely killed the internal fungal germ without impairing the germinating capacity of the tubers. But, since continued soaking for such a period in hot water softened the tissues and made them susceptible to subsequent rotting he applied dry heat instead by suspending a water-tight cylinder containing the potatoes to be cured, in hot water raised to 42-56° C till the temperature inside the cylinder recorded 40° C for 4 hours. Seed tubers sown after this dry heat treatment gave rise to healthy offsprings but the latter's immunity was not assured as the 'late blight' fungus could and easily did spread in such a healthy cultivation through secondary infections from adjacent diseased plots. So, to avail full advantage of this method of blight control it becomes imperative that adjacent plots should contain no diseased plants and the cultivators in a said locality must act co-operatively together.

Because of the latter conditions this method of combating potato blight was not adopted in any measurable scale beyond Denmark, the home of its origin But it was soon thrown into the background by the then discovery in France a couple of years later of Bordeaux mixture, which proved so efficacious in controlling the potato blight disease by checking secondary spread of infection and which moreover, did not call for that type of co-operation imperative for the success of the hot-water method. But to-day Jensen's method holds a special offer to be taken full advantage of by countries that have run short of copper, a cheap and invariable ingredient of Bordeaux mixture, due to the impact of war.

But the method evolved first for potato soon found a world-wide application for prevention of seed-borne diseases of cereals, and recently of other crops.

Earlier to the application of the hot-water method all efforts at controlling loose smut of cereals proved a failure; and the reason for this escaped detection so long. And this, too, was left to the investigation of Jensen to show that the loose smut fungus, as in the case of blight disease fungus of potato, was an internal parasite living in a dormant way within the body of the grain. So surface sterilization with any fungicide so long proved a total failure. Jensen, therefore, subjected loose smut infected cereals to hot water at 50-52° C for 10 minutes; the seeds then became completely free from smut 'germ'

In later years the researches of Appel and Riehm (1911) have proved the accuracy of Jensen's method. They have further shown that the process could be hastened by pre-soaking the seeds for a

few hours in water at ordinary temperature before putting them in hot water.

Jensen's hot-water method, despite the difficulty in maintaining accurate temperature range when treating bulks, is still considered as the only successful measure against loose smut disease of wheat, oats and barley; and moreover this principle is now being increasingly availed upon to disinfect seeds, setts, or any other plant parts that are used for vegetative propagation where the disease germ, fungus, bacterium or nematode, is carried within the body of the 'seed' and is therefore inaccessible by any other means.

Indigenous modification of Jensen's hot-water method have been devised by various workers to suit local conditions. In India Luthra and Sattar (1934) employed with equal effectiveness solar energy in place of hot water. Here the seeds are first soaked in water at ordinary temperature (as suggested by Appel and Riehm) in bright day from morning to noon (1 P. M.) and are then exposed in thin layers to the full action of the sun where in the plains of Punjab the temperature reaches as high as 129° F or more in the summer. Mitra and Taslim (1936) could employ with success Luthra and Sattar's modified method under North Bihar conditions. Similarly Lamb (1933) is reported to have successfully disinfected cotton seed attacked with bacterium (Bacterium malvacearum) by exposing them in an iron dish to the full action of the sun daily for a fortnight in the month of June under Nigerian conditions where the day temperature sores as high as 60° C. Successful results have also been reported by other workers; Wager (1935) could control brown rot of tomato caused by Phytophthora parasitica by immersing the fruit for 1½ minutes in water at 60° C, while Ogilvie and Brain (1936) could cure rust in mint by subjecting the runners used for vegetative propagation for 10 minutes in water maintained at 105-115°F.

The Helminthosporium disease is known to cause a serious loss to rice cultivation. The causative Helminthosporium fungus lives on the glumes and on the surface and inside the tissues of the fused pericarp and seed-coat (Nisikado and Miyake, 1920). Whether on the surface or inside the tissues of the fused pericarp and seed-coat the fungus is shut off fitting glumes (Tisdale, 1922). Necessarily externally applied seed disinfectants will scarcely be able to get in and affect the pathogen. This is the reason which so long baffled all attempts to proper sterilization of seeds through externally applied fungicides. The seeds are now being treated as under hot-water method at 52° C for 8 - 10 minutes after pre-soaking in water at ordinary temperature for 8-12 hours. This gives absolute control of the primary infections, but since the disease

spreads in the field through secondary infections a foliage spray in addition is called for to get absolute control.

Application to Control virus Diseases.

Jensen's hot-water method evolved for curing seed-borne diseases of plants has now found an application to kill the active principles of the virus disease that live within the body of the plant. So setts or cuttings obtained from virus infected plants are first cured of the virus germ by subjecting them to Jensen's hot-water method before planting. But the results achieved here have not been as uniform. While Miss Wilbrink (1923) claims to have destroyed the virus agent in Black Cheribon sugarcane setts by treating them in hot water at 52-55°C for 30 minutes, Brandes and Klaphaak (1923), working with G. C. 7C1 variety of sugarcane, came out to say that immersion at high temperature (45-55° C) for shorter period or at low temperature (43 48°C) for longer period (up to 90 hours) could not cure the setts of virus germs. Blodgett's investigations (1923) on leaf-roll and mosaic of potato also support Brandes and Klaphaak's contentions. But the extensive researches conducted by Kunkel (1936) on peach yellow viruses suggest that different virus has different lethal temperature and this needs to be separately studied and determined

Application to Control Nematode Pests.

The hot-water method, so successful against seed-borne diseases, is now being increasingly employed to control certain of the nematode pests where the worm perpetuates, as in the case of fungal and virus diseases, from one generation to the next by being carried within the body of the bulb or other vegetatively propagated parts.

Ramsbottom was the first to try in the year 1918 the hot-water method against the nematode pest (Anguillu'ina dispsaci) of narcissus bulb. A 3-hours' treatment in hot water at 110°F is now prescribed for complete elimination of the worms from within the body of the bulb without impairing in any way the germinating capacity of the latter. Since then and especially from the early 'thirties' of this century this aspect of the nematode pest control is being increasingly studied; and encouraging results have been obtained by English and American authors on chrysanthemum, strawberry, violet, begonia, etc.

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Extract from Science and Culture. Vol. X-No. 3 Septembe 1944,

VOL. XIX NOS. 3 & 4

The Nagpur Agriculture College Magazine.

March & June 1945.

PRINTED BY K. N. PAONASKAR AND V. K. SHEOREY, M. A.
AT THE ARYAN PRESS, NAGPUR.

PUBLISHED BY MR. N. M. JOGLEKAR, M. A., LL. B.
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CONTENTS

The Nagpur Agriculture College, Nagpur

Vol. XIX | March & June 1945. | Nos. 3 & 4

Editorial

SOLDIERS AS FARMERS

One of the important problems of the present transitional stage in India's agricultural economy is the provision of employment to a large number of ex-servicemen. The development envisaged in the field of industry should, in the long run provide ample opprotunity to personnel trained in the use of machinery and tools, but a large number of soldiers who were engaged in jobs to which no civilian counterparts exist will have to look forward to eventual absorption in agriculture. Many of these hail from rural areas and their settlement on land will only be natural. The pre-demobilisation training in scientific agriculture and in handicrafts which is being imparted at various army-centres will stand them in good stead in settling themselves in peace time occupation.

The settlement of the ex-soldiers on land, apart from being a solution to the problem of providing a source of maintenance to them, is likely to have a very salutory effect on the agricultural occupation and rural life in general. The life in a fighting forces and the training received therein goes a long way to mould and fashion the aptitude and capacity in a person. Dvelopment in the physique, resourcefulnees, self reliance, sense of discipline and practice in team work are the special features which mark out one who has gone through the vigorous military training and served in the best traditions of India's fighting forces. Wherever they go they are sure to make the best of the circumstances, influence their surroundings and

enthuse their fellowmen to follow them. The innate intertia,fettering fatalism and tramelling traditions of the rural population will be stamped out by the sturdy hands of those who have seen new lands and have broadened their outlook. Popularization of the improved methods of agriculture, introduction of spare-time employment and cooperative organization of farming will be facilitated by their example.

In this war C. P. & Berar provided 60,000 recruits and 200 Emergency Commissioned Officers.

"The Provincial Goverment hopes to be able to settle a certain number of men on land of their own. For men of agricultural background, schemes are under way for settlement in model villages. where land will be prepared for agriculture and where technical advice will be freely available. About 51,000 acres have already been earmarked for this purpose. It is hoped that about 50, 000 acres will eventually be available for allotment, some of which being in scattered plots, will attract men of the locality. It is intended to put the land into such a state that men will be able to begin cultivation at once. They will be formed into multi-purpose cooperative societies, and for the first few years officers of the Agriculture and other departments will be available to advise thim. It is not, however, intended to spoon-feed the men completely. If they are to succeed they must be self-reliant. One suggestion made is that the Government should bear the expense of getting the land fit for cultivation in the first year and that the men should be expected to use their savings and deferred pay for building homes, buying animals, etc. This will not be enough usually and to tide over their financial difficulties, these cultivators will be helped by the cooperative societies, and it may be necessary to give taccavi and even grants.

Government also proposes to lay out the roads, dig wells and make tanks if needed for watering animals, and if necessary, free grants of timber will be given during the first few years. The land selected for the purpose mostly lies in the districts of Chanda, Nimar, Balagat, Bilaspur, Mandla and Yeotmal."*

In establishing colonies on new lands the experience of the Punjab Canal Colonies will be helpful. It is found there that the small farmers who work under the direction of a central

authority are able to effect a number of economies and can make their farms pay better than when ran independently. Assistance in formulating cropping schemes, use of irrigation facilities, provision of seed, manure and in the marketing of farm producuts proves very valuable. It will be interesting to watch how joint or cooperative farming on large scale scores over the present disintigrated small scale farming.

The pit-falls must be avoided. Mr. L. K. Elmhirst points out that one is too ready to forget the ex-soldier once his need is over. In some countries the ex-soldiers' settlements have dwindled into rural slums. "Out of sight, out of mind" let him not starve, in the "homes for heroes."

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* C. P. & Berar Review, Vol. II, No. 39 Nov. 1945.

† Proceedings of the Indian Society of Agricultural Economics-Dec. 1944.

Russia Grows Natural Coloured Cotton.

**Vast Range of Hues and Shades
Light and Dark Blue, Green, Pink, etc.**

Everything from coloured cotton—shades of pink and green on the bolts—to a tremedous increase in production of new varieties of tougher cotton and new machinery for processing has been achieved or promised in the near future, according to reports from the cotton industry in Russia.

The All-Union Cotton Research Institute has been co-ordinating all experiments and has planned greater production, with particular emphasis upon the development of Central Asia.

At the same time the Cotton Goods Workers Union, in the process of reconversion to peace-time production, has been making use of the Stakhanovite movement to increase the volume and quality of cotton goods.

Mikhall Alexandrov, Director of the Research Insitute, has reported that "selectionists" working on the development of woolly cotton and natural coloured cotton have produced "exceedingly interesting" results. One of these new varieties has a brown-coloured fibre.

At the Turkmenian Experimental Station he says, cotton is being developed in the following shades—light and dark blue, green, pink and smoke colour.

"The work on the green varieties is almost finished and apparently within the next few years we shall be able to culvivate cotton with a vast range of hues and shades".

Alexandrov adds that experiments indicate natural coloured cotton produces a greater length of better quality yarn to the mass of raw cotton.

"Laboratory experiments also show that the colour is very fast and tends to deepen rather than fade under the action of soap and even when washed in a weak solution of lye in hot water. The only exception is the brown fibre which tends to change colour under the influence of sunlight but industrial laboratories have developed methods of fixing the brown colour by processing it with copper and chromium salts".

(Continued on Last Page.)

Improvement in the yield of Paddy

[A review of work done by the Department of Agriculture, Central Provinces and Berar in the past and in the present under the 'Grow More Food Campaign'.]

by

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DEPUTY DIRECTOR OF AGRICULTURE, EASTERN CIRCLE, RAIPUR.

RICE is by far the most important food crop in the Central Provinces and Berar, occupying over 57 lakhs of acres out of about 247 lakhs of acres under cultivation. The Provincial output of cleaned rice amounts to a little over 16 2 lakhs of tons of which 1.7 lakhs of tons is exported. The imports are inappreciable amounting to 4,400 tons of rice only, showing that the province is a surplus province so far as rice is concerned. It is an important money crop in the Chhatisgarh division where about 80 per cent of the rice area is concentrated and hence the attention of the Agriculture Department, since its organisation in 1906 was engaged in the improvement of its yield and quality. The need has however, been felt more keenly in the present times since the fall of Burma which deprived India of about 15 lakhs of tons of rice and thereby creating an ever increasing demand for it. In this article the work done by the Agriculture Department in the past has been reviewed and the more fruitful schemes that are being carried out at present under the 'Grow More Food' campaign, with the results achieved so far have been described.

PROPAGANDA ABOUT TRANSPLANTATION IN THE CHHATISGARH, FROM 1906—1923.

The rice area in the province is roughly divided in two parts viz:

(a) Wainganga valley comprising Chanda, Bhandara and Balaghat districts and Seoni tahsil of Chhindwara district.

(b) The great inland basin of old Chhatisgarh division comprising Raipur, Bilaspur and Drug districts.

In the Wainganga valley with 14.3 lakhs of acres under rice about 70 per cent of the area is transplanted while in Chhatisgarh with 36.0 lakhs of acres hardly 1 per cent area is transplanted, and even this small area is ,confined to tracts bordering on the districts where transplantation is already in vogue. The rest of the area is *biasted* i. e., where paddy is sown broadcast with a seed rate of about 100 lb. per acre and subsequently ploughed and crossploughed to thin out the seedlings when they are about 6″-7″ high Trials conducted on Government Experimental Farm, Labhandi, Raipur, from 1906 onwards showed conclusively that transplantation gave an increased outturn of about 500 lbs. of paddy per acre. The earlier workers could not satisfactorily account for this important difference in agricultural practice between these two tracts, which are situated at no very great distance from each other and between which there is a good deal of inter-communication. The three districts of Chhatisgarh were regarded as the most backward agricultural tract in the province and the Chhatisgarhi was recognised as one of the laziest and the least enterprising of cultivators. The earlier workers therefore, having convinced themselves of the superiority of transplantation regarded this as the best and most effective way of improving the yield of paddy. A vigorous propaganda was carried out to educate cultivators in the method of transplantation. Many facilities were extended, inducements offered and in some cases even moderate pressure was exercised for the rapid spread of transplantation which was then calculated to increase the profits of the farming community of Chhatisgarh by nearly four crores of rupees annualy. *

Unfortunately these efforts did not bear the ambitious fruits anticipated and transplantation though increased from 68.4 to 71% in the Wainganga valley it expended from1.3% to 1.4% only in Chhatisgarh during 1906—1923. The factors operating against the general adoption of this useful practice were to be found in certain economic and physical conditions of the tract and not as much with the Chhatisgarhis themselves. These have been brought out by Moharikar (1) and Allan (2) and are summarised in brief below:—

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* D. Clouston. : The Transplantating of rice in Chhatisgarh. Agricultural Journal of India, October 1908 Vol. III, part IV P.P. 339

(1) Annual Reports on the demonstration work carried out in the Eastern Circle, Raipur C. P. 1923—1942.

(2) Allan. R. G.-A consolidated record of field experiments 1906—1930.

(1) *Absence of assured irrigation facilities.*

Transplantation delays ripening by a couple of weeks or so and in the absence of assured irrigation facilities, a condition, far from universal in Chhatisgarh, biasi is safer. Out of the total area under paddy in Wainganga valley 45% was irrigated while only 8% was under irrigation in Chhatisganh in 1923. Even in 1943 with repid advancement in irrigation only 17 p.c. of the paddy area is protected. Transplantation is, therefore, to be found on areas protected by a tank but could not be followed elsewhere.

(2) *Non-existence of a seedling area.*

Transplantation demands the existence of a seedling area protected from grazing and the transport of seedlings to the field. Where holdings are of fair size and reasonably consolidated this provides no difficulty, but in an area like Chhatisgarh where fragmentation is intense conditions militate against its popularity. A malguzar with his fields in some measure consolidated may be induced to transplant but the cultivator whose fields are to be found in perhaps twenty insolated blocks has no inducement to adopt the practice. Consolidation of holdings is therefore, a necessary precedent to transplantation and unless it is achieved in a fair degree transplantation cannot be undertaken.

(3) *Want of sufficient number of strong cattle.*

This is also one of the important reasons for the prevalance of biasi. The rice area per pair of cattle in Wainganga valley averages to 3.7 acres while in Chhatisgarh it averages to 5.9 acres. In fact it comes to 11.8 acres per pair when it is realised that two pairs of weak and small sized animals generally available in Chhatisgarh are required to do as much work as one strong pair found ordinarily in the Wainganga valley. One pair of cattle is necessary for transplanting 5 acres and as such the population of plough cattle falls short in this tract.

(4) *Limited time for operation.*

Transplantating on any wide scale makes a very heavy demand on labour over a short period i. e., 15th June to 31st July of which a week is utilised for sowing, a fortnight for ploughing and the rest period for transplanting. In fact it postulates a considerable density of population to permit any wide application. In many parts of Chhatisgarh the population

is by no means dense and the absence of sufficient casual female labour renders impossible the common adoption of this practice. A Chhatisgarhi therefore, follows biasi by which he carries out sowing from 15th May to 15th July and biasi from 1st July to 14th August and thus spreads his work over a longer period and manages it with the available labour.

(5) High intensity on a crop postulates high priced land. It also assumes the existence of a high standard of living. Neither of these operate over a large part of the rice tract. In their absence a more extensive system is in all probability sounder especially when under the first reason it may be safer.

As the outcome of the operation of one or other and indeed at times several of these factors the application of this assured method of increasing yields has only made progress in certain tracts and that too to a limited degree. It has shown vividly that application of agricultural research is subject to limitations imposed by the economic and physical conditions prevailing in a tract. This line of propaganda has therefore, to be given up in Chhatisgarh and other factors affecting the yield of paddy were taken up from 1923.

RESEARCH WORK DONE BETWEEN 1923—1943.

Having been convinced that biasi has come to stay research work was directed to such problems as evolution of higher yielding strains, eradication of wild rice, locally known as *Karga* which is an attendent evil of biasi cultivation, manurial requirments and other cultural problems affecting the growth and yield of paddy. Some of the promising early selections and hybrids evolved by the Second Economic Botanist during 1923—33 were E. B. 17, Surmatia, Bhondu, Bhondu X parewa, Hardigabh, Luchai, Gurmatia and Fine Chinoor. Of these Luchai, Gurmatia, Surmatia and Bhondu X parewa were the most popular, the first two having the greatest demand in the market and the last two being very useful for eradicating *Karga*. The experiments conducted on Government farms, private demonstration plots and on cultivators fields showed that these improved strains gave as much as 10—25 per cent higher yield than the older varieties. These promising lines of work were taken up independently by the Rice Research Scheme financed by the Imperial Council of Agricultural Research from 1933. As a result of eight years of research work some excel-

lent selection from existing varieties and hybrids of great value in eradicatiod of *Karga* have been bred (1). Some of the results of economic value are summarised below.

(1) The production of improved strains.

Out of the collection of nearly 700 varieties grown in the province the following high yielding strains of ordinary and fine scented rices have been evolved to suit the varying requirements of the different rice districts. They have been found to give 10—25% higher yeild than the old standard varieties at Raipur and other centres of the rice tract.

Table No. I

Strains	Time of ripening sowing time middle of June	Yield in lb. at Raipur, average 1937—1941.
Ordinary varities—Early		
•R 2 Nungi (No. 17)	October 3rd week.	1304
•R 3 Sultugurmatia	October 4th week.	1630
Medium		
R 4 Surmatia	November 1st week.	1501
R 5 Ludko	November 2nd week.	1636
Late		
•R 6 Budhiabako	November 3rd week.	1618
•R 7 Ajan		
Gurmatia	do	1872
•R 8 Benisar	do	1471
•R 8 Luchai	November 4th week.	1808
	do	1678
Fine scented rices-Medium		
•R 10 Chhatri	November 1st week.	1247
R 11 Dubraj	November 2nd week.	1378
•R 12 Banspatri	do	1501
Late		
R 13 Kubrimohar	November 3rd week.	1581
R 14 Badshahbhog	November 4th week.	1403
Very late		
•R 15 Chinoor	December 1st week.	1569

(1.) Annual Reports of the Rice Research Scheme C. P. Raipur, 1934–1942.

N. B.—All the above varieties are suitable for Chhatisgarh. Those that are marked * are recommended for Wainkanga Valley.

(2) *The wild rice problem and its solution*

It is a problem specific to Chhatisgarh. The incidence of this weed in biasi fields was studied in detail by Dave (1) and was found to vary from 3 to 30 per cent causing an estimated loss of over 22 lakhs of rupees. It is a weed which closely resembles the cultivated varieties and cannot be weeded out during the period of its vegetative growth. It can be distinguished only when the ears are formed but on account of its characteristic nature of shedding grain completely long before cultivated rices mature, it gets self sown and multiplied year after year. It has now been possible to prevent the above loss by the use of the following three high yielding purple leaved hybrids and three hybrids with dark purple auricles. The combination of high yield of the green parents like Luchai, Bhondu etc., and the purple colour of leaves and stem of the other parent Nagkesar of the dark purple auricles of parewa has enabled cultivators to distinguish karga in the seedling stage and eradicate it and at the same time obtain nearly as high yield as is given by the green parents.

Table No. II.

Hybrids	Time of ripening. Sowing time—middle of June.	Yield in lb. per acre.
Purple leaved hybrids		
Early		
Cross No. 1 (No. 17 x Nagkesar)	October 3rd week	1,112
Medium		
Cross No. 2 (Bhondu x Nagkesar)	November 2nd week.	1,439

1 Dave B. B.: The wild rice problem in the Central Provinces and its solution. Indian Journal of Agricultural Science, February 1943 Vol. XIII part I.

Hybrids.	Time of ripening. Sowing time—middle of June.	Yield in lb. per acre.
Late		
Cross No. 5 (Luchai x Nagkesar)	November 4th week.	1,552
Hybrids with dark purple auricles.		
Medium		
Cross No. 116 (Bhoudu x parewa)	November 2nd week.	1,987
Cross No. 22 (Bhondu x parewa)	—do—	2,000
Late		
Cross No. 19 (Budhiabako x Parewa)	November 3rd week.	1,757

(3) *Manurial requirements of rice in the Central Provinces.*

Fertilizer experiments conducted from 1935—1942 have conclusively proved that 20 lb. Nitrogen in the form of Ammonium Sulphate with 20 lb. phosphoric acid in the form of double super phosphate per acre is the most economical dose at prewar rates and gives significantly higher yields than either 20 lb. Nitrogen or 20 lb. phosphoric acid applied alone, which in turn give significant increases in yield over no manure. As fertilizers were not available during wartime, experiments were laid out on manuring paddy with oilcakes in 1942-43. The results obtained at the Rice Research Station Raipur and other places show that 60 lb. Nitrogen supplied through oilcakes more than doubled the yield, while 40 lb. and 20 lb. Nitrogen gave as high a yield as 60 per cent and 33 per cent respectively over no manure. This has enabled the cultivators to fix the most economical dose by taking into consideration the prevailing rates of paddy and oilcakes and obtain the maximum profit per acre.

'GROW MORE FOOD' CAMPAIGN.

In the beginning of 1943 when due to war the food situation in India began to cause anxiety and it was felt that 'Grow More Food' campaign should be launched and inten-

sified so as to increase food production to the utmost extent possible, the Agriculture Department of the Central Provinces was fully equipped with the up-to-date results on the methods of improvement of yield in paddy. Food production drive schemes and paddy seed distribution scheme were taken up forthwith from 1st April 1943. Both the ways of increasing production (A) by increasing the area under paddy and (B) by improving the yield of paddy were advocated. The schemes with the results achieved during 1943-44 have been summarised below :—

(A) INCREASING THE AREA UNDER PADDY.

This is being achieved by :

(i) Bringing poor land under cultivation.

(ii) Diverting rabi area to paddy.

(i) *Bringing poor land under cultivation.*

In the prewar days when the rates of paddy went as low as 50-60 lb per rupee many lands on the margin of profit were kept fallow. With the present rate of paddy of about 10 lb. per rupee cultivators have been advised to bring all such lands under cultivation. Many malguzars who could not manage vast lands owned by them are now cultivating such lands on 'Adhiya'. It is expected that about a lakh of acres might thus be brought under paddy again.

(ii) *Converting rabi fields into paddy followed by utera (catch crop.)*

In the rice tract cultivators have been advised to divert as much rabi as possible to paddy particularly wherever irrigation facilities exist. The best paying rabi crop at present is wheat but the calculations based on a normal yield and on current prices show that unirrigated paddy will give about Rs. 6-12-0 more profit and irrigated paddy about Rs. 35-12-0 per acre more profit than wheat. Where *utera* follows paddy there will be an additional profit of about Rs. 6/- per acre. The Central Government sanctioned Rs. 3 lakh for converting 20,000 acres of rabi area into paddy of which Rs. 1 lakh to be given as subsidy to cultivators and Rs. 2 lakhs as taccavi loans repayable in five years and carrying 3½ per cent interest. The response to this item has been very favourable.

(B) IMPROVING THE YIELD OF PADDY

This is being achieved in the following ways :—

(i) Multiplication and distribution of improved varieties of rice mentioned above.

(ii) Distribution of oilcake for manuring paddy.

(iii) Distribution of sannseed free of cost for green manuring paddy.

(iv) Construction of small village tanks and repairs of old tanks for irrigating paddy.

(i) *Multiplication and distribution of improved varieties of rice.*

A scheme financed by the Provincial Government and the Imperial Council of Agricultural Research is in force from April 1942 and provides for rapid multiplication of improved rice strains and hybrids by organising a chain of central seed farms and seed multiplication centres all over the rice tract of the province under departmental supervision. The seed so produced is collected and distributed in a systematic manner, the sequence being as follows.

Governmentd Experimental Farm, Raipur.

Six Government seed and demonstration farms.

160 Central seed farms of 50 acres each—80,000 acres.

800 Seed multiplication centres of 50 acres each — 40,000 acres.

4,000 seed farms of 50 acres each—200,C00 acres.

During 1943-44 the sequence of distribution upto 800 seed multiplication centres has been carried out and 44,675 mds. of improved seed has been actually distributed. During 1944-45 all the seed from Government farms and half the produce of the seed multiplication centres would be taken over and distributed to 4000 seed farms of 50 acres each. The total number of villages where improved seed was escpeeted have been distributed by the end of June 1944 was be (160 + 800 + 4000) = 4960 *i. e.*, about onethird the number of villages in the rice tract and the area on which improved seed will be grown would be 2·48 lakhs of acres. It is expected that the improved varieties will then become sufficiently well known and within the reach of every village and

further expansion could be left to natural spread. Even assuming that improved strains give an increased outturn of only 10 per cent over ordinary varieties, the additional quantity of rice produced and the money earned by the cultivators would be appreciable.

(ii) *Distribution of oilcake for manuring paddy.*

To supplement the stock of Farm-yard manure and to substitute the fertilizers like Ammonium Sulphate and Niciphos which are not available during wartime the Central Government has sanctioned Rs. 2½ lakhs would be given as subsidy to cultivators and Rs. 7½ lakhs as taccavi loans repayable in two years free of interest. It will be sufficient for manuring 54,000 acres at the rate of 5 mds. of cake *i. e.* 20 - 30 lb. Nitrogen per acre according to the quality of cake. The rates of oilcake have gone very high as is the case with other commodities and this timely help from the Goverment in the form of subsidy has enabled the cultivators to take full benefit of the scheme and grow more food for the country and make more profit for themselves. The demand for oilcake is great and it was expected that the whole allotment would be utilised before June 1944.

(iii) *Distribution of sann seed free of cost for manuring paddy.*

Wherever transplantation of paddy is carried out green manuring is possible. The seed is sown in the month of May if irrigation facilities exist or with the first monsoon shower in June and allowed to grow for about a month or so. It is ploughed in at the time of preparing land for transplantation in the middle of July. It supplies about 20—30 lb. Nitrogen per acre according to the growth made. The Central Government has sanctioned Re. 70,000 for purchase of sann seed and its free distribution for green manuring paddy and wheat. During 1943-44 most of the allotment was utilised. It is gratifying to note that some cultivators have already approached the department for supplying sann seed during 1944-45 season either free or at half or full cost as the case may be.

(iv) ***Construction of small village tanks and repairs to old tanks for irrigating paddy.***

One irrigation at the time of biasi and one at the time of ripening are necessary for rice crop in this tract to ensure a normal crop against the vagaries of monsoon. These are

known as protective irrigations and save a crop which in the absence of timely rain or these irrigations, would barely give 50 per cent yield. Proposals to sanction Rs. 5 lakhs for construction of small village tanks or for repairing old tanks which generally can protect 25—100 acres of paddy grown under them are with the Government. Out of this amount Rs. 1 lakh would be given as subsidy to cultivators and Rs. 4 lakhs as taccavi loans repayable in five years and carraying 3½ per cent interest per annum. Cultivators are very keen to avail of this concession and it is expected that if the loan is given it would protect atleast 15,000—20,000 acres thereby ensuring a normal crop over that much more area and also enabling the cultivators to pay off the loan from the extra profits that they would earn.

CONCLUSION.

The "Food production Drive" Schemes and the paddy seed distribution scheme have added substantially to the agricultural wealth of the province, accelerated the 'Grow More Food' campaign and helped to some degree to replenish the all India deficit which formerly was met by imports from Burma. Besides they have been of great value to the research workers as well as the demonstration and propaganda staff on account of their bridging the wide gulf between the laboratory and the cultivator's field. Sir John Russel (1) has expressed the great need of doing so and these schemes have served the very purpose within as short a time as possible. The financial help which is so very necessary in giving a number of ocular demonstrations to cultivators has been provided in them with the result that very wide publicity could be given to the results obtained by the Rice Research Scheme, Raipur. They have enabled the propadanda staff to judge more correctly the scope of expansion of various results obtained in the laboratory and the experimental farms and have also brought to light many other problems that confront the practical farmer and which require solution either in the laboratory or in the economic sphere. In fact the schemes have proved a very valuable link through which research could be planned and propaganda work guided.

1 Russell E. J. —Report on the of the Imperial Council of Agricultural Research in applying science to crop production in India 1937.

Fusarium Wilt On Linseed

by

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In the course of investigations on the water requirement of linseed (*Linum usitatissimum*) some plants were observed withering at the flowering stage. Some plants were partially affected while in others only the leaves of solitary branches exhibited normal turgidity, the rest becoming flaccid. The diseased plants were examined by Dr. R. P. Asthana, M.Sc., Ph.D., Mycologist to the Government of the Central Provinces and Berar, who reported that the plants were infected with *Fusarium lini* B. causing wilt.

The genus *Fusarium* has been found to cause wilt in various crops like gram, tur, cotton, sannhemp., potatoes. Beans, etc., by various workers. Prasad and Padwick (1939) have made critical study of its various sub-sections and species. They have also mentioned *F inil* Boll occurring on linseed. *F.inil* is described originally by Bolley (1901) as " definitely having sporodochia with 4-celled conidia". According to Wollenweber and Reinking (1935) sclerotia may or may not occur in the sub-section (*F. Orthoceras*). The only case where they are mentioned is in *F.lin*, a species which they consider to be, as regards form of macroconidia, a bridge between *F.Orthoceras* and *F.Oxysporum*. Prasad and Padwick have further remarked that the *F.lini*, in potato dextrose agar culture, showed distinct tendency to produce a purplish lilac colour in the aerial mycelium and a deep purple, lilac or violet hue in the substrate, varying presumably with the acidity or alkalinity of the medium. It also produced a thin layer of spores on the agar surface, resembling pionnotes. In nature, according to Wollenweber and Reinking, it sometimes produces sporodochia, and in the form of conidia (as said adove) is a bridge between *F.Orthoceras* and *F.Oxysporum*. It produced abundant chlamydospores at 35° c and few at 20° c.

The pathological aspect of *F.lini* in field conditions, however, has not yet been studied in great details. In 1942-43 and again in 1943-44 it was observed by the author to cause wilting in linseed grown in pots having three different types of soils and different percentages of soil moisture. The observations are discussed in this article.

Three varieties of linseed viz. Nagpur local, F. B. 3 and O. S. X. were grown in pots having three different soils viz. *Bardi* (red sandy loam), *Morand II* (loam) and *Morand I* (clay loam). These pots were irrigated with tap water twice a week in order to maintain 20, 30 and 40 percents soil moisture in these soils. The incidence of *Fusarium lini* was not so marked in 1942-43 as in 1943-44. The same soils of 1942-43 were used in 1943-44.

The first symptoms of attack were quite striking as the tips of plants first started drooping down, while turgidity was maintained in other parts of the plants. Sometimes the tips of one or two branches only developed this symptom whereas other branches seemed quite healthy. Within a day or two, the lower leaves of the affected branches became flaccid. In general all branches were simultaneously affected, but in some cases one or two branches were left quite healthy in appearance, the rest of the plant having wilted. This nearly aroused suspicion that the wilting might have been caused by insects attacking the roots and destroying them partially. When, however, some of these partially wilted plants were uprooted and examined, the suspicion of insect attack was waved off as the roots were found to show definite symptoms of *Fusarium* attack which was later confirmed by the Mycologist to Government, Central Provinces and Berar. The attack was noted after about three weeks of sowing and plants in flowering and fruiting stage were affected.

The wilted leaves were seen to hang vertically downwards with a slight curvature giving them the appearance of small boats. The freshly wilted leaves maintained the green colour even when they were completely dead and fragile.

The infected roots were found to have the characteristic lesions, specially at the ground level. The bark was completely shredded and in some advanced cases it was covered with a white mycelium. When the wilted plants were pulled

out, the lower portions of the main taproots and their branches were found without epithilial layers. Wood was discoloured and presented smokey brown colour. The vascular bundles were filled with fungal hyphæ.

The incidence of the disease was most severe on the red soil, probably on account of its porosity and high organic manurial contents and lower percentage of potash. A few pots of *Morand* II were also affected. *Morand* I did not show any infection till the end of February 1944 when a few plants in the pots were attacked. This indicated that the pathogen is a soil-borne one. The incidence was 61.1 per cent on *Bardi*, 15.2 per cent on *Morand* II and 9.5 per cent on *Morand* I soil. From the chemical aspect of the soil, it was found that *Bardi* soil was rich in organic matter, phosphoric acid, and nitrogen and deffiicient in potash when compared with the other two soils. This lack of potash in the *Bardi* soil may account for the high percentage of infection therein.

Varietal resistance to the disease was also exhibited. The O.S X. variety was comperatively the most susceptible, the percentage of incidence being 48.6. The E. B. 3 linseed was less susceptible with an infection of 22.2 per cent. The local linseed faired the best, having only 15.2 per cent wilted plants.

Analysis of the effect of the soil moisture on the disease has shown that the highest percentage of infection was on 30 percent soil moisture, the infection being low in 20 per cent and 40 per cent soil moisture.

In *Morand* II soil, the disease first appeared on 20 per cent soil moisture while in *Morand* I soil the infection was observed only on 30 per cent soil moisture, 20 and 40 per cents being free, It was further observed that additions of 0.01 per cent solution of mercuric chloride when added to partially wilted plants, gave them a fresh lease of life for a day or two.

Summary:

(i) *Fusarium lini* B. was observed to cause wilt of linseed sown in pots in 1942-43 and again in 1943-44.

(ii) Of all the three varieties, linseed O.S.X. was the most susceptible, the least being the Local variety.

(iii) The infection was highest in red *Bardi* soil, less in *Morand* II and the least in *Morand* I soil.

(iv) 30 per cent of soil moisture gave the highest percentage of infection.

Acknowledgements.

My thanks are due to Dr. G. S. Bhatia, M. Sc., Ph. D. (Lond.), F. L. S., F. R. H. S., Second Economic Botanist to Government, Central Provinces and Berar and Dr. R. P. Asthana, M. Sc., Ph. D., Mycologist to the Government, Central Provinces and Berar, for providing facilities and guidance in this work.

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Cost of Living Index Number.

by

M. P. Shrivastava, M. Sc.,

Index Number.

INDEX is a commonly known word and has a wellknown meaning. It indicates or points out something. An index number has an allied meaning. Its function is to indicate changes in a time or place series. In social, economic and political fields, change is the general law. An indication of this change in an easily intelligible, interpretable and comparable form becomes an essential adjunct to its objective valuation. Hence the need for and the origin of index numbers.

2. The change may be confined to one variable. One may, for example, be interested in the change from year to year in a particular country in the production of wheat as a measure of self-sufficiency in food requirements of its people; or in the number of industrial workers as a measure of industrial development; the number of graduates as a measure of educational advancement; or the membership of a particular political party as a measure of the ascendancy or decay of a particular school of political thought. Often, however, an event in economic, social or political field is interrelated with several similar and dissimilar events, and interest lies in evaluating the cumulated result of changes in these several events, or variables as we may call them, taking place at the same time. Production of wheat alone will not indicate the degree of self-sufficiency of a country with regard to its food requirements. All cereals and allied staple food articles will have to be considered. Number of industrial workers alone will not suffice to indicate industrial development of the country; industrial production and imports and exports, both quantitative and qualitative, will also have to be considered. Similarly, in auditing educational advancement or political developments several allied factors will have to be considered in the light of their respective importance. It is in such

complex situations that this mathod of fact analysis–the Index Number–is found immensely useful.

3. We shall start with a simple case of one variable. Suppose that it is required to find the comparative rise or fall in the price of a particular article throughout a number of years or other periods or points of time such as months. The idea of comparison makes it incumbent to choose a significant basis on which comparisons are to be made. In a time series of the type considered, the price of the article at one of the points of time, or its average price for a number of points of time, is taken as the suitable basis or standard. Prices at all other points of time are then compared to this standard. This point or length of time, the price of which is taken as the standard for comparison is technically called the base period. For example, if we have a series of monthly average prices for a particular grade of rice and if we are interested in the course of these prices during war, we may choose August 1939, the prewar month, or September 1938 to August 1939, the prewar year, as the base period and compare the monthly prices from September 1939 onwards with the average price for this chosen base.

4. Now, comparisons are made in two ways. One is the method of differences and the other is the method of ratios. Suppose, for example, that the price per maund of a particular grade of rice was Rs. 4-0-0 in August 1939, Rs. 4-4-0 September 1939, Rs. 4-8-0 in October and November 1939, Rs. 5-8-0 in December 1939,............ Choosing August 1939 as the base period and the method of differences as the method of comparison, we may say that as compared to August 1939, the price of rice was Rs 0-4-0 per maund higher in September, Rs. 0-8-0 per maund higher in October and November and Rs. 1-8-0 per maund higher in December 1939,............

5. This is a perfectly legitimate comparison. When the series expand and extend to several months, however, the serial enumeration of the absolute differences fails to carry the real impression about the price rise. In keeping in mind a series of such differences, which often rise or fall erratically, the basic quotation that rice was selling at Rs. 4-0-0 per maund in August 1939 not being directly and forcefully implied in the comparison, is likely to be lost sight of. Simple differences do not, therefore, afford an easy channel of effective comparison.

6. We, therefore, turn to the method of ratios. In this case we would say that the price of rice in September 1939 was $1\frac{1}{16}$ times its price in August 1939: in October and November it was $1\frac{1}{8}$ times: in December $1\frac{1}{4}$ times;................. As pure and simple ratios are often cumbrous to handle, we resort to percentages, round off the decimal points by ignoring an error of unit in the result and say, speaking relatively, that, if the price of rice for August 1939 is taken as Rs. 100-0-0 per maund, then it was Rs. 106-0 0 per maund in September, Rs. 112-0-0 per maund in October and November, Rs. 125-0-0 per maund in December 1939............... As a meaure of further simplification, we drop the monetary prefix and, speaking in terms of relative numbers only, say that, with August 1939 = 100 as the base, the index number of the price of rice was 106 for September, 112 for October and November, 125 for December 1939,.... ....

7. The merit of this technique is obvious It carries the basic quotation inseparable, and indicates clearly and effectively, without the confusion attending the serial enumeration of original prices or their absolute differences from a fixed base, exactly proportionate or comparative changes, and is, therefore, to be preferred.

This explains, in brief, what an index number connotes. When, however, we come to several variables, for example, to the general price level, the problem becomes complex. When two periods are compared the prices of different goods and services are found to rise or fall by varying amounts. It price indices for each of these articles are prepared for any point of time and are thrown into frequency form, the resulting distribution is usually found to be asymmetrical with positive skewness. This is apparently inherent in the very nature of the variables—the price indices. No price index can be zero or less than zero; whereas there is no limit to which it may rise. It is a variable for which the lower bound is zero but the upper bound is open Consequently, the price dispersion upward always or usually exceeds the price dispersion downward.

9. This gives rise to a very important question. What function of these several price indices would best represent the change in the general price level? If we take a simple arithmatic average of these indices, the significance of the

resulting index is bound to be materially affected. The simple arithmatic average is an unbiased measure of central tendency only for normal distributions, whereas the distribution we are dealing with here, is definitely skew. If we use the geometric mean, or the median which closely follows the geometric mean, we can ensure that large deviations above it count for no more than small deviations below it, but whether any deviation of a given magnitude relates to essential food articles or to so-called non-essential toilet luxuries, its effect on the index would be the same. If, therefore, an average is to be used—and for index numbers we seldom go beyond averages owing to the complexities of other multivariate functions, we have to choose an average in which the price index of any article shall influence the final result only in proportion to its relative importance in the scheme under consideration. Thus, having determined the purpose for which the several variables are to be combined into a single representative figure, we have to determine the importance to be attached to each of these variables in relation to the field considered and then to strike an average in which each variable is weighted according to its importance. In the case of the general price index, for example, each article may be weighted in accordance with its importance in relation to the welfare of the community.

10. By necessity price indices were the first to come. But the field of index numbers is now almost as extensive as the field of statistics. They are being extensively used in relation to such data as those pertaining to production, financial matters, individual abilities and efficiency and so on—that is, in respect of a vast variety of data in which variation is brought about by the varying influence of several factors and for which an indication or estimation of the composite variation is desired to be evaluated. It is not necessary here to enter into their illustration. The essential points that need attention in each case are firstly, the clear conception of the purpose for which the index is designed, and secondly, with respect to this defined purpose:

(a) the selection of the items or variables to be included in the index,
(b) the importance to be attached to each of the selected items of variables,
(c) the ascertainment of the variation of the character under study of each item, and

(d) the method of combining the variations of all items to secure a single comprehensive figure to represent effectively their combined effect, influence or action.

COST OF LIVING.

11. With this prelude we turn to the cost of living and then to the cost of living index number. Cost of living, spoken of in comparative terms, has several connotations. It is a common-place mention these days that the cost of living is much higher now than what it was before the war. This expression has no single unequivocal meaning. 'Cost of living' is a complex of three sets of variables—the spending power measured by nominal or money income, the standard of living, and the prevailing prices; and a change in cost of living may be brought about by a change in any one, or two or all the three sets of variables.

12. To illustrate we shall consider a particular family. The idea can be easily extended to a group by considering the particular family to be an average family, as an average family is but a mathematical abstraction for the group The following reasoning should, in fact, be taken as being applied to an average family and, therefore, to a group rather than to a particular family. For, in social and economic fields we are interested in the masses and not in the individuals.

13. Speaking for any particular family then the simplest meaning of the expression that cost of living is much higher now than before the war would be that—

(i) its income does not now buy as much as it did before the war. It also means that

(ii) the money cost of maintaining its present standard of living is greater than the money cost of maintaining its standard of living before the war; or that

(iii) the money cost of maintaining a certain fixed standard of living is greater now than before the war.

And from the point of view of practical living the expression often implies that

(iv) the family concerned has greater difficulty now in maintaining its present standard of living on its present income than it had before the war in maintaining its then prevailing standard of living on its income at that time.

14. More interpretations are possible; but those given above would suffice as being more relevant to the subject under discussion.

15. The question then arises: what meaning should we attach to the phrase 'cost of living' in order to be able to measure changes in the cost of living at different points of time in a way which will have a purposeful and utilitarian meaning? The first interpretation involves two sets of variables—namely income and prices and has not much value in the present connection as it cannot give any tangible idea of how the cost of living is actually affected. The second interpretation involves prices and the standard of living; the third involves prices alone, and the fourth involves all the three sets—prices, standard of living and income. Each of these three sets of variables consists of several variables, and a simple mathematial consideration would ordinarily suggest the choice of the third interpretation, as computational difficulties are bound to increase with the increase in the number of variables, mostly correlated, which the other meanings involve. Mathematics has, however, to be a tool here and not the main determinant. The economic aspect of the problem has to be looked into before mathematical simplicity is given preference and made the criterian of choice.

16. From the point of view of the economics of practical living, the fourth interpretation has the greatest significance. Income, standard of living, and prices are all inter-related in a complex manner. Far more important, however, is the inter-relation between prices and the standard of living — the second interpretation of the cost of living. Income limits the standard of living, but it is, in effect, the prevailing type and extent of expenditure that determines that standard at a particular time. It also represents the finally adjusted situation which reflects at once the inter-play of needs, tastes, spending power, prevailing prices and managerial ability. But this identification of changes in actual expenditures with changes in the cost of living has two hurdles to cross, one theoretical and the other practical.

17. The theoretical consideration is this: does the actual expenditure incurred during different periods ensure the family or group concerned the same amount of goods and services or the same satisfaction, or is it affected by un-ignorable circumstances favourable or unfavourable ? If the money cost of living rises, but the material satisfaction derived from it actually goes down as is probable during days such as the present, then the comparison of actual expenditures as a measure of change in the cost of living is certainly not in keeping with what humanitarian considerations would put as desirable from the stand point of general well-being. If the money cost of living rises or falls and the standard of living also rises or falls correspondingly or in a different proportion, the comparison would again be inapt for other considerations, for example, considerations of relations between employers and employees when the working classes are concerned.

18. The practical consideration is this. In social and administrative fields we are interested, not in individuals, but in groups. And, for groups, unless they are extremely limited, it is well nigh impossible to ascertain their average expenditure from month to month not only for reasons of cost but also for reasons of time. Even if we could, the material utility of such findings may not be worth much. In normal times the change from month to month in the average expenditure is not likely to be at all appreciable: in abnormal times the theoretical considerations given above become practical live issues.

19. For the purpose of the cost of living index number, therefore the interpretation of the cost of living as meaning the money cost of maintaining a certain fixed standard of living, the third interpretation has ultimately to be depended upon. The fixed standard of living is to be defined by a certain aggregate of goods and services, definite in regard to kinds and quantities. The fixation of this aggregate, however, involves fairly important considerations. Should it be determined by theoretical norms of consumption to be set up by experts on the basis of certain objective criteria or should it relate to the actually prevailing level of living at a particular time ?

20. In its broadest sense, the standard of living, speaking in the language of economics, *i. e.* taking out its moral and

cultural aspects, refers to the quantities and qualities of food, shelter, clothing and miscellaneous commodities and services that an individual or a group deems necessarily desirable to the enjoyment of life. In practice, however, the ideals of the group, the size of the family income and the level of prevailing prices become the fundamental determinants of that standard. Even scientifically standardized norms will not carry conviction and be practised if they are divested of the prevailing habits of living or if the consciousness of the group as a whole is not awakened. For purposes of the cost of living index number therefore we identify the standard of living of the group concerned with its plane of living, during preferably normal times, determined through family budget enquiries, and expressed in a concrete from, by means of average consumption quantities of, or expenditure on, selected goods and services

THE COST OF LIVING INDEX NUMBER.

21. The cost of living index number is thus designed to measure changes, in one period of time as compared to another the base period, in the cost of a certain aggregate of goods and services determined by the actual level or standard of living of the class concerned prevailing generally in a normal period; this normal period generally coincides with the base period, but it is not strictly necessary and may not always be possible.

22. We now revert to the different points about an index number summarised in paragraph 10 and see how they stand vis-a-vis the cost of living index number The first point, the purpose of the index, is too obvious now to need any explanation. All that needs extra emphasis is that the socio-economic group to which the index is to refer should be as homogeneous as possible in respect of all factors that affect the standard of living, specially the factors such as family income, nature of work and social and communal habits or general mode of life.

23. The second problem, the selection of items to be included in the index, is, however, important. Any family budget enquiry would reveal the consumption, even by a poor class like labour, of a variety of goods and services out of which a set of the more important and representative ones

has to be selected. The selected items are to be representative in the sense that changes in their cost should indicate fairly closely the changes in the entire cost of living. This selection is made on commonsense principles The main idea is to pick up all essential articles and to cover as large a proportion of the total expenditure as possible. This is sometimes affected by considerations of whether a particular article belongs, relativaly, to a group of conventional necessaries, or semi-luxuries, or luxuries. But a more modifying consideration is the case of securing comparative price quotations from time to time. About 40 to 50 articles are usually found to be sufficient.

24. The importance to be attached to each of the selected articles is as is obvious from the definition of the index itself, proportionate to the average expenditure incurred on it, or equal or proportionate to its quantitative consumption measured in respective appropriate units.

25. When the articels to be included in the index are selected, the problem of ascertaining their prices from time to time becomes simply a question of setting up of a suitable machinery for it. Two points only need attention. Firstly, the prices at different times for each article should refer to the same grade or quality, the grade which is most commonly consumed by the class concerned. Secondly, the prices ascertained should be the same as are actually paid by that class. They should, therefore, be collected from shops catering for, and, as far as possible, in units of measurement used by that class. Further, as prices are likely to vary from locality to locality, and even from shop to shop in the same locality, they weality should be collected from different shops in representative localities, so that the average prices are able to eliminate zonal differences.

26. With the selection of the articles, the determination of their importance, and the collection of appropriate prices, the construction of the cost of living index number reduces to a mere numerical routine. When the importance of the articles is expressed in terms of the average consumption quantities, all that is required is to find, as explained in paragraph 21, the cost of this quantitative aggregate in the two periods, the base period and the period concerned or the cunrent period as we may call it, and to work out what

percentage the latter is of the former or to find the value of the latter assuming the value of the former to be 100. Thus, if

N is the number of articles selected, Q_{0i} is the quantity associated with the i^{th} article, P_{0i} and P_{1i} are the prices per unit of the i^{th} article in the base and current or "o" and "1" periods respectively, and I_{10} is the index number for the period "1" with the period "o" as base, then

$$I_{10} = \frac{P_{11} Q_{01} + P_{12} Q_{02} + \dots\dots + P_{1N} Q_{0N}}{P_{01} Q_{01} + P_{02} Q_{02} + \dots\dots + P_{0N} Q_{0N}} \times 100$$

$$\text{Or} = \frac{\Sigma P_{1i} Q_{0i}}{\Sigma P_{0i} Q_{0i}} \times 100 \qquad \dots\dots\dots \qquad (1)$$

where Σ is a well known mathematical symbol, indicating that the quantities $P_{1i} Q_{0i}$ or $P_{0i} Q_{0i}$ are to be summed up for all values of i from $i=1$ to $i=N$. In plain language we have

$$\left.\begin{array}{l}\text{Index number for the}\\ \text{period "1" with the}\\ \text{period "o" as base.}\end{array}\right\} = \left\{\begin{array}{c}\dfrac{\text{Cost of the fixed aggregate in period "1"}}{\text{Cost of the same aggregate in period "o"}}\end{array}\right. \times 100$$

27. When the importance of the articles is expressed by means of proportionate or percentage expenditure incurred on them we have to work out individual price indices, namely $(P_{1i} / P_{0i}) \times 100$, and then to strike the weighted average. Thus, assuming the weight attached to, that is, the proportionate or percentage expenditure incurred during the base period on, the i^{th} article to be W_{0i}

$$I_{10} = \frac{W_{01} \dfrac{P_{11}}{P_{01}} \times 100 + W_{02} \dfrac{P_{12}}{P_{02}} \times 100 + \dots + W_{0N} \dfrac{P_{1N}}{P_{0N}} \times 100}{W_{01} + W_{02} + \dots\dots W_{0N}}$$

$$= \frac{\Sigma W_{0i} \dfrac{P_{1i}}{P_{0i}} \times 100}{\Sigma W_{0i}} \qquad \dots\dots\dots\dots\dots (2)$$

28. The former method is known as the 'aggregate expenditure method' and the latter as the 'weighted price relative

methed'. As W_{oi} is proportional* to $P_{oi}\,Q_{oi}$ to the formulae (1) and (2) give the same result.

29. Generally a family budget is conventionally divided into five standard groups of expenditure, namely, food, clothing, light and fuel, house rent and miscellaneous and separate index numbers are worked out for each group. This has an intrinsic value in practice, but it involves no new principle. The working line given for a set of *N* articles in paragraphs 26 and 27, can be used for each of the standard groups separately; the same method can then be extended to the groups themselves. The numerical illustration given in the appendix will make the point clear.

USE OF COST OF LIVING INDEX NUMBER.

30. Cost of living index numbers are generally constructed for industrial labour. Their main use is to determine their real wages, the question of whose adequacy forms one of the principal causes of labour disputes. The money that an individual gets for his work, the nominal wage as it is called, has its worth in its exchange value only. This worth consists in the goods and services that he can command for that money. The value of the nominal wage in terms of the goods and services that it can obtain, called the real wage, depends, thorefore, upon the general price level; and is given by the formula:

$$\text{real wage} = \frac{\text{Money wage}}{\text{Cost of living index number}} \times 100.$$

Thus, if a worker was getting Rs. 12-0-0 per month before the war and is getting Rs. 25/- per month at present, he would ordinarily appear to be pretty well off. If, however, the present cost of living index number on the prewar base stands at 250, his real wages reduce to Rs. 10-0-0 per month only, so that actually he may be running short of two prewar rupees worth of goods and services and may, therefore, be leading a correspondingly lower standard of living.

31. A few words of caution in the use of cost of living index numbers would appear appropriate at this stage. There

* Actually $W_{oi} = P_{oi}\,Q_{oi} / \Sigma P_{oi}\,Q_{oi}$
or $= (P_{oi}\,Q_{oi} / \Sigma P_{oi}\,Q_{oi})$.

will be no confusion in their use if their conception and back-ground is kept in mind, and if it is remembered that they are ratios of two linear functions having the same set of constants—the consumption quantities or proportionate expenditures. There are some points, however, which need special stressing, specially for those who do not want to worry about the mathematical back-ground. The first point is this. Differential rise in the index number at two places is generally confused with differential costs of living at two places. If the index number at Bombay stands at 150, and that at Nagpur at 200, the question is generally asked: how can it be? The cost of living is higher in Bombay than in Nagpur; how can the Nagpur index be higher than the Bombay index? This is an innocent misunderstanding. The cost of living index is no pointer to the actual cost of living; it is only concerned with the change in the cost of living. If for the same social and economic class having an equally sized average family the original monthly costs of living at places *A* and *B* were Rs. 40-0-0 and Rs. 25-0-0, meaning that *A* has a higher cost of living than *B*, and if these costs change to Rs. 80-0-0 and Rs. 50-0-0 respectively, the indices for both places would be the same, namely, 200. It can also happen that the cost of living at *A* goes up to Rs. 72-0-0 and that at *B* to Rs. 50-0-0, so that the cost of living index is 180 at *A* and 200 at B; but it does not mean that *B* has become costlier than *A*. A reverse situation may also occur.

32 The second point is this. Cost of living is a relative thing–relative with respect to time, persons and place also. The index is related to the standard of living of a particular group in a particular place and can, strictly speaking, be applicable to that group only. The index that is applicable to wage earners will not apply to businessmen or to clerical staff.

33. Confusion is also sometimes made in regard to the size of family on the basis of which the cost of living index is prepared. It is, however, obvious from the definition that, though the actual cost of living depends upon the size of family, the cost of living index number is quite independent of it. The only effect of a varying family size would be to proportionately increase or decrease the set of constants, the weights or consumption quantities; but, as these constants appear both in the numerator and the denominator of the

ratio which constitutes the index, the proportionality factor automatically cancels out.

34. Two points more may be mentioned. The first is the inter-centre comparison of the cost of living index number. Whenever 'the indices at two places are compared, their entire structures–the number of articles included, the weights associated with them, the price variations and the base periods-should be borne in mind. The second is about their accuracy. The index is essentially a type of statistical average and is, therefore, both in construction and use, subject to all the rules and limitations associated with such averages. It is at best an approximate indication of conditions prevailing and no dogmatic assertion can be made about them in their application to problems of practical living. Their structure also needs revision at suitable intervals of time, as the standard of living, which fixes the set of constants in their make-up, progresses.

APPENDIX — NUMERICAL ILLUSTRATION.

Aggregate Expenditure Method.

Table 1 (a) below illustrates the numerical working of the cost of living index number for the food group by the *"Aggregarte Expenditure Method". Column (1) gives the articles selected for constructing the food index; column (2) the units in which the articles are measured; column (3), the quantities consumed per month by an average family; columns (4) and (5), the retail prices obtaining in August 1939 and July 1943 respectively. Multiplying column (3) by columns (4) and (5), we get in columns (6) and (7) the costs of quantities given in column (2) of the articles mentioned in column (1), and, summing up columns (6) and (7), we get the total costs of all those articles for the two months — August 1939 and July 1943. The cost of Living Index Number for Food or the "Cost of Food Index" for July 1943, with August 1939 = 100 as the base, is then given by :

$$\frac{\text{Cost of Food in July 1943}}{\text{Cost of the same food in August 1939}} \times 100.$$

$$= \frac{49.169}{13.099} \times 100.$$

$$= 375.364 \text{ or } 375.$$

* This illustration has been adopted from the working class cost of living index number at Cawnpore for the month of July 1943, with August 1939 as the base, vide 'Labour Bulletin', Vol. II, No. 3, pp. 16-17, New Series, published by the Labour Department, United Provinces, Cawnpore.

2. The index numbers for the cost of other standard groups of expenditure, such as clothing, fuel and light, housing and miscellaneous, as well as that for the total cost of living are worked out on similar lines as indicated in Table 1 (b).

TABLE 1 (a).—WORKING CLASS COST OF LIVING INDEX NUMBER

at A

for the month of July 1943.

(Base period — August 1939 = 100).

	Articles.	Unit of measure-ment	Quanity consumed*	Price per Unit August 1939	Price per Unit July 1939	Cost August 1939 (3) x (4)	Cost July 1943. (3) x (5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Food.			Rs.	Rs.	Rs.	Rs.
1.	Wheat	Seer	48·4	0·078	0·403	3·775	19·505
2.	Birra	,,	11·4	0·068	0·306	0·775	3·488
3.	Gram	,,	4·6	0·083	0·307	0·382	1·412
4.	Rice	,,	11·4	0 115	0·528	1·311	6·019
5.	Tur dall	,,	8·6	0·120	0·412	1·032	3·543
6.	Mutton	,,	2·2	0·344	0·724	0·757	1·593
7.	Sugar	,,	1·4	0·297	0·406	0·416	0·568
8.	Ghee	,,	2·2	1·099	3·534	2·418	7·775
9.	Mustard oil	,,	2·2	0·365	0·940	0·803	2·068
10.	Potatoes	,,	8 0	0·130	0·341	1·040	2·728
11.	Salt	,,	5·0	0·078	0 094	0·390	0·470
	Total.		....	....	....	13·099	49·169
	INDEX		....	....	....	....	375

* This refers to quantities consumed per family per month. The actual size of the family and the period to which the quantities refer do not affect the index. Never-the-less, it is customary to base the calculations on the quantities consumed by the average family during the period for which the family account is taken during the family budget enquiry.

TABLE 1 (b).—GROUP INDICES AND THE TOTAL COST OF LIVING INDEX.

Group (1)	Cost in August 1939. (2)	Cost in July 1943. (3)	Index number for July 1943. [(3) ÷ (2)] x 100. (4)
1. Food	13·099	49·169	375
2. Clothing	1·871	5·898	315
3. Fuel & light	2·495	11·063	443
4. Housing ...	2 183	2·183	100
5. Miscellaneous	1·871	4·962	265
Total.	21·519	73·275	340

Weighted Price Relative Method.

3. Table 2 illustrates the working of the cost of living numbers by the " Weighted Price Relative Method " Columns (1) and (2) are just the same as in Table 1. Column (3) gives the weight to be attached to the different articles; columns (4) and (5), the prices during August 1939 and July 1943 respectively. Dividing column (5) by column (4) and multiplying the result by 100, we get in column (6) the price index for July 1943 with August 1939 = 100 as base. Multiplying column (6) by column (3), we get in column (7) the numerical share that each article has in the make-up of the index, and summing up column (7) and dividing the result by 100, the sum of the weights attached to the different articles, we get the cost of Food Index as shown in the Table 2 (a).

4. The index numbers for the costs of other standard groups of expenditure are worked out in a similar manner. These index numbers are then combined to get the total cost of living index number by treating the different groups of expenditure in the same way as the individual articles are treated within a group. This is illustrated in Table 2 (b).

5. The weight attached to any article within a group, as mentioned in paragraph 27 of the text, is simply the percentage expenditure incurred on that article during the base

period. Thus, from column (6) of Table 1 (a), the expenditure on wheat during August 1939 is seen to be Rs. 3·775 out of a total expenditure of Rs. 13·099 on Food. The weight to be attached to wheat in the construction of the Cost of Food Index is, therefore, (3·775/13·099) × 100 = 28·8. Similarly, from column (2) of Table 1 (b), the expenditure on Food during August 1939 is seen to be Rs. 13·(99 out of a total expenditure, on all articles, of Rs. 21·519. The weight to be attached to the Food Group in the construction of the total cost of living index number is, therefore, (13·099/21·519) × 100 = 60·9.

TABLE 2 (a).—WORKING CLASS COST OF LIVING INDEX NUMBER.
at A
for the month of July 1943.
(Base period — August 1939 = 100.)

	Articles.	Unit of measurement.	Weight.	Price in August 1939	July 1943 Price.	July 1943 Price index [(5) ÷ (4)] X 100	July 1943 Weight X Price Index (3) X (6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Food.			Rs.	Rs.		
1.	Wheat ...	Seer	28·8	0·078	0·403	517	14,889·6
2.	Birra	,,	5·9	0 068	0·306	450	2,655·0
3.	Gram ...	,,	2·9	0·083	0·307	370	1,073·0
4.	Rice ...	,,	10·0	0·115	0·528	459	4,590·0
5.	Tur dall ...	,,	7·9	0·120	0·412	343	2,709·7
6.	Mutton ...	,,	5·8	0·344	0·724	210	1,218·0
7.	Sugar ...	,,	3·2	0·297	0·406	137	438·4
8.	Ghee ...	,,	18·5	1·099	3·534	322	5,957·0
9.	Mustard oil	,,	6·1	0·365	0·940	258	1,573·8
10.	Potatoes ...	,,	7·9	0·130	0·341	262	2,069 8
11.	Salt	,,	3 0	0·078	0·094	120	360·0
	Total ...		100·0	...	....	...	37,534·3
	INDEX ...		....	....	....		375

TABLE 2 (b).—GEOUP INDICES AND THE TOTAL COST OF LIVING INDEX.

Group. (1)		Weight (2)	Group index (3)	Weight X group index [(2) X (3)] (4)
1. Food	...	60·9	375	22,837·5
2. Clothing	.	8·7	315	2,74 ·5
3. Fuel & light	....	11·6	443	5,138·8
4. Housing	....	10·1	100	1,010·0
5. Miscellaneous	....	8·7	265	2,305·5
Total	..	100·0	....	34,032·3
INDEX	...		..	340

Making Cotton Fireproof.

That "Fasbos" will save cotton from fire has been discovered by an Alexandria cotton export agency.

The agency has sent a letter to the Egyptian Ministry of the Interior informing it of the discovery and stating that when this substance (composed with one of the products of the Imperial Chemical Industry), named "Fisbos", is spread on the sacking or any other material in which cotton bales are wrapped, the cotton becomes immune to fire.

The discovery will save thousands of cotton bales that are destroyed by fire every year either in depots or while being transported down the Nile to Alexandria.

—*The Indian Textile Journal Vol. LV. No. 660, Sept. 1945.)*

VOL. XX NOS. 1 & 2.

The Nagpur Agriculture College Magazine.

September & December 1945.

PRINTED BY K. N. PAONASKAR AND V K SHROREY, M.A.
AT THE ARYAN PRESS, NAGPUR

PUBLISHED BY MR. N. N. JOOLFKAR, M.A., LL.B.
COLLEGE OF AGRICULTURE, NAGPUR.

CONTENTS

The Nagpur Agriculture College Magazine.

Vol. XX } *September & December '45.* { Nos 1 & 2

Editorial

Food Policy for India.

THE recent announcement made by the Government of India in respect of the future food policy of the country rightly recognises itsideal to be the promotion of the welfare of the people and securing the progressive improvement of their standard of life. This involves the responsibility for the provision of enough food for all, sufficient in quantity and of requisite quality. For achieving this objective high priority will be given to measures designed to augment the food resources of the country to their fullest extent and particularly to the methods calculated to increase the outturn of food crops by intensive cultivation and protective measures.

Difference is rigidly made in the long and short period policies. The immediate policy will be to raise as much more of food as possible in order to remove the occurance of a famine. The long period policy will be shaped so as to increase the prosperity of the cultivator and also to raise the lavel of consumption so necessary in creating a healthy and vigorous population.

A sound policy of such a nature when carried out with the fullest coöperation of the Provincial, Central and States Governments will not only ward off the imminent danger of famine but will also help to ensure the adequate feeding of the growing population of India.

TOPATO PLANT

By

G. S. BHATIA, Ph.D., (London), F.L.S., F.R M.S.

It was published in the Nagpur Agriculture College Magazine, August 1940 that "In the belief that potatoes are fattening, many people with a tendency to stoutness eat sparingly or not at all of this vegetable. In the future they may be able to eat potatoes to their heart's content without risk of adding to their too solid flesh. A horticulturist at Yonkers, New York, has produced in his greenhouse a starch-less potato. Called a "topato", the new plant is the result of the successful grafting of potatoes and tomatoes the fattening tendency of the one being balanced by the slimming quality of the other. The 'topatoes' grow from the roots of the plant in the manner of ordinary potatoes; the upper branches of the plant yield tomatoes"

In order to confirm the above results, the writer has successfully grafted tomatoes on potato plants as shown in the Figure. Potatoes and tomatoes were sown side by side. the former in the soil and the latter in pots Potatoes were sown on 25-11-1944, whereas the tomatoes were transplanted from nursery sown about fifteen days earlier than the potatoes. When the potato plants were about one month and three weeks old, the tomatoes were enarched on the potato plants. Seventeen such plants were enarched, but only four came out successful. Further work is in progress to confirm the remaining results.

" Topato " Plant.

Farm Compost.

—: कम्पोस्ट :—

या

गोशाला की खाद ।

वह दिन न फिर मिलेगा
सुन लो किसान भाई ।

१

सोते पड़े थे कब तक ! दुनिया है कबसे जागी,
विपदाओं से घिरे थे, घर में कमी थी आगी ।
दुनिया में है भयंकर, होने लगी लड़ाई,
वह दिन न फिर मिलेगा, सुन लो किसान भाई ॥

२

है बढ़ गयी जरूरत, अन्नों की बढ़ी मांगें,
तुम भी कदम बढ़ाओ, सरकार हुई आगे ।
है हाथ में अब चांदी करते चलो कमाई,
वह दिन न फिर मिलेगा सुनलो किसान भाई ॥

३

दो साल में ही देखो कैसे गरीबी भागी,
तेजी के इन दिनों में, तकदीर सबकी जागी ।
है नव वसंत आया, खेती बहार लाई
वह दिन न फिर मिलेगा सुनलो किसान भाई ॥

४

गोबर व कूड़े कचरे, गोदन पेशाब गौका,
कम्पोस्ट उसको कहते, मिश्रण गोशाल गौका ।
खेती की उपज इससे है आ रही बढ़ाई,
यह दिन न फिर मिलेगा सुनलो किसान भाई ॥

५

इसके बनाने के हैं सुंदर सरल तरीके,
इसके समक्ष जितने भी लाभ हुए फीके ।
सीखो सुविज्ञ जन से, अपनी करो भलाई,
वह दिन न फिर मिलेगा सुनलो किसान भाई ॥

६

पोषक बनें जगत के, उन्नत किसान होवें,
ऋण के न भार ढोवें, धनपति किसान होवें ।
श्रीपति किसान होवें कर अन्न की कमाई,
वह दिन न फिर मिलेगा सुनलो किसान भाई ॥

७

पैदा अनाज करके काफी जगत में भर दो,
निज दीनता भी हर दो भूखों के पेट भर दो ।
खेती की बही गंगा कर पुण्य लो कमाई
यह दिन न फिर मिलेगा सुन लो किसान भाई ॥

(कवि—उदय)

ORIGINAL ARTICLES

Studies in the grams of the Central Provinces & Berar

III, Correlation of some characters in gram

By

E. D PIMPLIKAR, (Agricultural Research Institute, Nagpur)

Introduction .—

The chief objective of a plant breeder while dealing with a diverse variety of plants and types is to look for a plant which shows improvement in quality and quantity. The latter being, in general, the most important. Quantity is expressed by the ultimate grain weight or yield of plant and it is invariably associated with some other measurable characters. To a plant breeder knowledge of these is of paramount importance since it helps him in making selection work. The results of such study in four fixed hybrids, their parents and one selection of C. P. grams forms the subject matter of the present paper.

Material and Methods :—

The data collected are on a varietal trial of gram carried out in the area of the Second Economic Botanist C. P. Nagpur in the year 1936 under the guidance of Mr. K. P. Shrivastav, the then Second Economic Botanist C. P. The experiment consisted of 7 strains, viz., (1) E.B. 401 (2) E.B. 402 (3) E.B. 403 (4) E.B. 404 (5) D8 (6) E B. 62 (7) E.B. 28 replicated four times in randomised blocks each plot being 1/40th of an acre The important characters of the strains under observation are tabulated below :—

Strains	Flower colour	Size of flower	Pod size	Seed coat colour	Maturity	Remarks.
E.B. 401	Pink	Medium	Medium	Y. Brown	Medium	Cross 98x62
E.B. 402	"	"	"	"	"	do
E.B. 403	White	"	"	O. Yellow	"	do
E.B. 404	"	Small	"	"	"	do
D8	"	Medium	"	"	"	Selection
E.B. 62	Pink	"	"	Medium	"	"
E.B. 28	"	"	"	"	Early	"

Five plants selected at random were marked in each plot and were under observations for the following characters :—

1 Number of flowers per plant
2 Number of nil seeded or empty pod per plant.
3 Number of fertilised pods per plant.
4 Number of one seeded pods per plant.
5 Number of two seeded pods per plant.
6 Total number of pods per plant.
7 Number of seeds per plant.
8 Weight of seeds per plant.

Thus there were 20 plants of each strain under observation. Some plants, however, did not survive till the end. The original data given in the appendix ii and the analysis relate only to those plants which survived till the end.

Number of flowers per plant :—

The number of flowers appearing on each plant were recorded daily for all the plants selected. The duration of flowering did not vary much in the different strains the range being 17-24 days.

The analysis of variance of the data is given in table : –

TABLE I.

Analysis of Variance of flower per plant.

Strains	D. F.	Sums of square	Mean square
E.2. 401	14	6367.15	454.79
,, 402	15	5083.55	338.90
,, 403	11	14982.42	1362.03
, 404	15	7808.60	520.57
D8	11	4209.20	382.65
E.B 62	9	7592.00	843.55
E.B. 28	14	15098.75	1078.45
Between plants	89	61141.67	

Due to	D.F.	Mean square	
Blocks	3	1231.65	
Variation	6	2796.68	
Error	18	727.68	3.8
Between Plants	89	686.97	4.7

S.D. 26.98

The proper error for comparing the effect of the strain is to compare the mean square for varieties with 6 D-F against the error mean square with 18 D.F. It will be observed from the value of F. that the varietal effect is significant.

It will also be noted that the error mean square with 18 D.F. is of the same order as that of the mean square between plants with 89 D.F. as and that with the mean square with 89 D.F. as error part the varietal effect is significant

It is possible as is shown in the table above to calculate the mean square between plants for each strain separately with a view to finding out the variability of the flower number per plant for the different varieties. The variability is of the same order. It will be noted that except Nos. 403, 28 and 62 for which the variability is greater, the variability for flower number in the remaining strain is of the same order.

For convenience, error part based on 89 D. F. is utilised for comparing the varieties for all the characters under study in the present investigation.

The mean number of flowers per plant for different strains is given in table 2 with its standard deviation per plant. The common S. E. for the mean is not given as the number of plants in each strain is different. The number of plant on which the mean is based in each strain is shown in the table.

TABLE II.

(Mean No. of flower per plant)

	E.B.	E.B.	E.B.	E.B.	E.B.	E.B.			
Strains	401	402	403	404	D8	62	28	G.M.	S.D.
Mean flower no.	38.5	53.2	81.1	57.3	52.1	45.9	49.7	53.7	26.98
Number of plants.	18	19	15	19	15	13	18.		

The mean number of flowers per plant is 53.7. It is lowest for strains E.B. 401 followed by E.B. 62 and E.B. 28 highest for E.B. 403.

Number of pods and seeds per plant :—

These charactors were studied when all the plants under observations were completely matured. Further, depending upon the nature

of their seed setting, the pods were grouped into classes of nil or empty, one, two, three seeded etc. In the present study three or more seeded pods were not observed. The percentage setting and the number of seeds per pod have got direct bearing on the yield of plant. It has been observed by Kadam, Kulkarni, and S. M Patel (1938) that flowers which are thrown out earlier tend to the formation of pods which contain more number of seeds while those developed from the later flowers contain proportionately number of one and nil seeded pods. In their study on ovule mortality in gram Pal and Narayanrao (1940) observe that all variations in the number of ovule per pod may be found within the same variety, but the proportion in which different ovule groups occur is a varietal character

Pods:—

In the present study the analysis of variance has been worked out for (a) nil seeded or empty pods, (b) one seeded (c) Total and (d) fertilised pods as is given below.

TABLE III.

Analysis of Variance (Pods per plant).

Mean Squares

Due to D.F.	Nil seeded F cal Obs 5 pc 1 pc	One seeded F cal Obs 5 pc 1 pc	Total pods F cal Obs 5 pc 1 pc	Fertilised pods F cal Obs 5 pc 1 pc
Blocks 3-9-75		344.62	469,22	346-50
Varities 6-9-89		269.50	287.82	300.18
Error 18-3-10	3 19 2.66 4.01	157.78 1.71 2.66 4 01	182.48 1 57 2.66 4.01	176.76 1.69 2.66 4.06
Bet. plant. 89-3-97		114.16	152.34	141.67

It will be observed that mean square between plants although slightly less except in the case of nil seeded pods is as one would expect, of the same order as the mean square, due to error with 18 D.F. Using 89 D.F. as an error part the varietal difference in respect of nil and one seeded pods is significant, that for fertilised pods almost approaches significance while that for total pods is not significant. Using however the mean square with 18 D.F. as error none of the factors except nil seeded pods reaches the level of significance. It will be seen that the significance of varietal difference in respect of nil seeded pods is confined only to E.B. 403

and D8 which together contribute most of the mean square as will be observed from the following table,

Strains	D.F.	Sum of square	Mean square
403 and D8 against rest	1	57.27	57.27
Rest	 5	2.11	0.42
	6	59.38	

Anylsing further the plant to plant variation it is comparatively higher for the three strains E B. 403, D8 and E.B. 62 as was the case in respect of flower character

The mean number of nil one, two seeded pods, total pods per plant, per-centage setting, percentage of one and two seeded pods etc. are shown in the table 4.

TABLE IV.

	401	402	403	404	D8	62	28
Nil seeded pods ...	1.4	1.3	3.5	1.1	3.1	0.4	0.5
One seeded pods ...	11.8	13.5	20.6	11.0	8.0	13.0	17.2
Two seeded pods .	0 5	2 6	2 5	3.0	1.2	1.6	0.6
Total pods ...	13.7	17.4	26.6	15.2	12.3	15.0	18.3
Fertilised pods ..	12.3	16.1	23 1	14.0	9.2	14 6	17.8
% of nil seeded pod ...	10 3	11.2	10.8	13.8	23 6	13.8	12 7
% of one seeded pod ...	86.1	72.3	75 2	65.9	65.1	85.1	82.1
% of two seeded pod ...	3 6	16.5	14.0	21.3	11.3	1.2	5.2
% of total setting ...	34.3	31.1	31.4	27.7	22.9	30.7	36.8

In the data examined the maximum number of seeds per pod observed did not exceed two. Other workers Kadam, Kulkarni and Patel S. H. (1938) and Pal and Narayanrao (1940) however have noted even three and four seeded pods in the same variety. The mean number of pods per plant is 17.02 No. 403 showing the highest i. e. 26.6 and D8 the the least i. e. 12.3. Numbers 403 and D8 show significantly higher number of nil seeded pods per plant. The mean % age of getting is 31.5 the highest being 36.8 in No. 28 and the least 22.2 in D8.

Number of seeds :—

It has already been observed above that all the ovules present in ovary do not always get fertilised. A higher percentage of nil

seeded pods would thus reduce the ultimate number of seeds and consequently the weight of seed per plant. As this character has got direct bearing on yield, the plant breeder has got to keep this factor in view while selecting a variety.

The analysis of variance of seed number for the different strains is given in table 5.

TABLE V.

The analysis of variance for seed number (per plant basis).

Due to	D.F.	Mean Square	F Obs.	Cal 5%	1%
Blocks	3	222.63			
Varieties	6	521.70	2.50		
Error	18	207.93			
Bet. plants	89	157.77			

It will be observed that mean square due to varieties is significant when compared with that for "between plants" and almost reaches 5% level of significance when compared with the mean square for 8 D.F. The varietale ffect is significant. Analysing further plant to plant variations it is comparatively higher as before for the three strains F.B. 403, 28 and 62. The mean number of seeds per plan(for the differant strains is given in table 6

TABLE VI.

Mean number of Seeds per plant

Strains	401	402	403	404	D8	62	28	G.M.	S.D.
Mean seed	13.0	15.7	25.5	17.1	10.6	14.0	18.4	16.35	12.56

The mean number of seeds per plant is 16.35 the maximum number being 25.5 for 403 and the minimum 10.6 for D8. Thus it will be seen that although strain 403 had the highest number of nill seeded pods because it contains proportionately more number of nil seed pods, scores in the end and has highest number of seeds per plant.

Yield per plant :—

The weight of seed per plant of all the strains in each replication was also recorded. The analysis of variance is given in table 7.

TABLE VII.

Analysis of variance (weight of seed per plant basis).

Due to	D.F.	Mean square
Block	3	5.46
Varieties	6	1.37
Error	18	2.84
Bet. plant	89	1.70

It is clear that the mean yield per plant of the diffetant strains does not differ significantly from each other. The mean yields are as under.

Yield in grams per plant in grams.

Strains	401	402	403	404	D8	62	28	G.M.	S.D.
Mean	1.5	1.8	1.2	1.2	1.1	1.8	1.2	1.6	1.3

The general mean is 1.6 grams. Nos. 402 and 62 given the highest yield of 1.8 grams plant while D8 gives the lowest of 1.1 grams per plant. Weight of 1000 seeds for each strain is as follows.

Stram 401 402 403 404 D8 62 28 weight in grams 120.0 103.05 100.30 109.40 169.08 116.81 128.70 G. M. 118.47

Correlation of plant attributes with each other and with final yield.

The correlation of diffarant plant attributes with each other and especially with the final yield is of considerable importance to persons interested in the improvement of plants. A plant breeder can do this selection work much more efficatiously if he is provided with the information of how some of the easily obserable plant characters are going to affect the final yeield. In the present

investigation the relationship of the following characters have been studied.

1 Flower with nil seeded pods.
2 Flower with fortilised pods.
3 Flower with total pods.
4 Flower with seeds.
5 Total pods with seeds.
6 Flower with yield.
7 Pod with yield.
8 Seed with yield.

(1)

Effect of flower number on the number of nil seeded or empty pods :—It is desirable to know if there exists any relation between flower number and nil seeded (empty pods). The analysis of Variance and covariance is given in appendix 1.

The relationship between the two factors can be judged by computing the value of "r" which is obtained by the formula $\frac{S x 1 \quad x 2}{\text{-}S x\ 2\frac{1}{2} \times S \times 22}$ The value so got, based on 89 D.F. is O. 288 which exceeds even the 1 per cent level significiance showing a significant positive correlation. The other alternative procedure of finding out the significance of the relation between the two factors is by comparing the contributions due to regression with that of deviation from regression. This test is carried out in the table below :—

TABLE VIII.

Significance of regression.

Due to	D.F.	Sums of Sq.	Mean Sq.		F.	
Regression	1	28.11	28.11	7.6	3.951	5%
Def. from reg.	88	325.26	3.69		6.93	1%
Total	89	353.37	3.97			

It will be observed that the mean square due to regression is significant exceeding even the 1%. This suggests the dependence of nil seeded pods on flower number, a conclusion as obtained previously.

In the table 8 general regression has been worked out from the squares and products obtained by combining all the strains together Such a combination is valid only when regression or correlation co-efficients for the different strains are of the same order. It is therefore necessary to split up the combined variance and covariance into variance and covariance between plants for the different strains and test the significance of the regression coefficient for the differant strains from the mean regression. This has been carried out in the following two tables.

TABLE IX.

Value of regression co-efficient within strains
(Flower x nil seeded pods)

Strains	D.F.	Sx_1^2	$Sx1 \times x2$	Sx_2^2	b_1	Due to reg. b_1, Sx, x2	Dev. from reg.	D.F.	Mean Sq dev. from reg	F.
401	14	6367.15	84.20	21 95	0.013	1.09	20.86	13	1.60	0.68
402	15	5083.55	138.00	22.40	0.027	3.73	18.67	14	1.33	2.80
403	11	15982.42	346.75	64.50	0.023	7.97	56.53	10	5.65	1.41
404	15	7808.60	201.80	72.80	0.025	5.05	67.75	14	4.84	1.04
D8	11	4209.20	429.60	75.05	0.102	43.82	31.23	10	3.12	14.04
62	9	7592.00	437.00	50.47	0.057	24.91	25.56	8	3.20	8.09
28	14	15028.28	296.70	46.20	0.014	5.67	40.53	13	3.12	1.81
Total	89	61141.47	1338.65	353.37	0 021	28.11	325.26	88	3.69	7.61

x1 = Flower.
x2 = Nil seeded pods.

TABLE X.

Test of significance of the difference of the regression co-efficient.

Due to	D.F	Sums of sq.	Mean sq.	Obs.	Calculated. 5%	1%
Mean regression	1	28.11	28.11	8.83	3.96	6.96
Dev. of variety regression from mean regression	6	64.13	10.69	3.36	2.21	3.04
Seven varity regr.	7	92.24	13.18	4.14	2.12	2.84
Dev from variety regression	82	261.13	3.18			
Total	89	353.37	3.97			

The mean square deviation of variety regression from mean regression exceeds the 5% level and is significant indicating that grouping of varieties and thus calculating mean regression is not justifiable. The mean square due to seven variety regression is also significant; but it will be observed from table IX from the comparision of the mean square due to regression and due to mean square for deviations from regression for each strain that the former is significant only in the case of the two strains D8 and 62. The contribution due to seven variety regression can therefore be splitted of between two groups i.e. five variety regression for 401, 402, 403, 404 and 28 and two variety regression i. e. for D8 and 62. The analysis of these is shown in the following table with the corresponding deviations from variety regression.

TABLE XI.

Grouping of 5 strains. 401, 402, 403, 404, 28				Grouping of 2 strains. D8 and 62.			
Due to	D.F.	Sums of sq.	Mean sq.	Due to	D.F.	Sums of sq.	Mean sq.
5 Variety regression	5	23.51	4.70	2 Variety regression	2	68.73	34.36
Deviation from variety regression	64	204.34	3.11	Deviation from variety regression	18	56.79	3.15
Total	69	227.85			20	125.52	

It will be seen that the mean square due to five variety regression compared to the corresponding deviation from variety regression is not significant; while in the case of the two strains D8 and 62 it is significant. The apparent significance of the seven variety regression was thus due to inclusion of two strains D8 and 62 in them.

It can be further tested if two strains D8 and 62 can be combined. The analysis will be as follows :—

TABLE XII.

Value of regression co-efficient within D8 and 62.

Variety	D.F.	Sx_1^2	Sx_1x_2	Sx_2^2	B	Bx_1x_2	Dev. from	D.F.	Mean sq.
D8	11	4209.20	429.60	75.05	0.102	43.82	32.83	10	3.12
62	9	7590.00	437.00	50.47	0.057	24.91	25.56	8	3.19
Total	20	11802.20	866.60	125.52	0 073	63.28			

Significance of general regression

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	F Calcu. 5%	1%
Regression	1	63.26	63.26	19.29	4.38	8.18
Dev. from reg.	19	62.26	3.28			
Total	20	125.52	6.28			

TABLE XIII.

Test of significance of difference of regression co-efficient for D8 and 62.

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	Cal. 5%	1%
Mean reg.	1	63.26	63.26	20.08	4.41	8.28
Dv of variety Reg.	1	5.47	5.47	1.74	4.41	8.28
Two variety regression	2	68.73	34.37	10.91	3.55	6.00
Dev. from variety reg.	18	56.79	3.15			
	20	125.52	6.28			

The variance due to deviation of varietal regression from mean regression for the two strains is not significant. It is therefore not incorrect to group the two strains together. The correlation between flower number and nil seeded pods for the two strains now work out to 0. 71 while for the other five strains it is 0. 14 which is insignificant.

It can be concluded from the above discussions that in these two strains viz. D8 and 62 more number of flowers result in more number of nil seeded or empty pods. On the remaining strains more of flowers do not necessarily produce more empty pods.

(2)

Effect of variable flower number on the number of fertilised pods:-

The study of dependence of fertilised pods on the number of flower would prove interesting. The analysis of variance and

covariance for these two characters are given in the Appendix I. x1 stands for flower number and x3 for the number of feitılised pods.

The correlatıon between flower number and number of fertilised pods based on 89 D.F. work out to 0.805 which is significant. Significance of the error regression is clearly brought out by apportioning the sums of squares into two parts i. e. that due to regression and the remaining due to deviation from regression.

TABLE XIV.

Significance of regression (between plant).

Due to	D.F.	Sums of sq..	Mean sq.	F Obs.	F Calculated 5%	F Calculated 1%
Regression	1	8164.95	8164.95	161.65	3 95	6.93
Dev. from reg.	88	84445 20	50.51			
Total	89	12610.15	141.67			

The mean square for fertilised pods is now reduced from 141.67 to 50.51. Most of the variation in fertilised pod number is thus attributed to the difference in the flowers on each plant.

In the above analysis a general regression is worked out by combining the plants of all the strains; but it remains to be seen how far such grouping is justifiable. The analysis of varianco and co-variance between plants with 89 D F. is computed as under. The different values of the regression co-efficient "B" are also indicated.

TABLE XV.

Value of regression co-efficient within strains

(Flower x fertilised pods).

Strains	D F.	Sx_1^2	Sx_1xx_3	Sx_3^2	b_2	Due to reg. b_2Sx, x_3	Dev. from reg.	D.F.	Mean sq. Dev. from reg	F
401	14	6367.15	2760.40	1502 80	0.433	1186.97	315.83	13	24.29	48 86
402	15	5083.55	2257.85	1820.75	0.444	993 45	827 30	14	59 09	16.81
403	1	14982.42	5006.75	2209.75	0 334	1652.22	557.53	10	55.75	29.63

Contd.

Strains	D.F.	Sx_1^2	Sx_1xx_3	Sx_3^2	b_2	Due to reg. $b_2 Sx1\,x_3$	Dev. from reg.	D.F	Mean sq. Dev. from reg	F
404	15	7808 60	1806.30	1221.55	0.231	415.42	806.13	14	57.58	7.21
D3	11	4209.20	735.30	311 55	0 186	141.42	170.13	10	17.01	8.31
62	9	7592.00	2864.00	1053.80	0 377	993 08	60.72	8	7.59	130.83
28	14	15098.75	686[illegible].00	4039.95	0 454	3037.90	1002 05	13	77 08	40.06
Total	89	61141.67	22343.40	12610.15	0.365	8164.95	4445.20	88	50.51	16 16

x1 Stands for flower.
x3 Stands for fertilised pods.

The test of significance of the difference of regression co-effi cients for the different strains from mean regression is worked out in table 16.

TABLE XVI

Test of significance of difference of the regression co-efficient.

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	F Cal. 5	F Cal. 1%
Mean regression	1	8164.95	8164.95	161.74	3.96	6.96
Dev. of variety regr. from mean regr.	6	305.53	50.92	1.01	2.21	3.04
Variety regression	7	8470.48	1210.07	23.97	2.12	2.87
Dev. from variety regression	82	4139.67	50.48			
	89	12610.15	141.67			

It will be observed that the deviation of varietal regression from mean regression is not significant and hence it is justifiable to work out the general mean by combining the plants of different strains Floweral number is positively correlated with the number of fertilised pods.

Test of significance of varietal differences in respect of the number of fertilised pods after allowing for possible effect of variable number of flowers :—

The table of analysis of residual variance is prepared in the usual way. The following results are obtained.

TABLE XVII.

Analysis of residual variance

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Bet. plant	94	5818.78				
Dev. from general regression	88	4445.20	50.51			
Variety	6	1363.58	227.25	4.5	2.20	3.?2

It is clear that vari^tal effect is still significant after allowing for flower number.

Calculation of mean number of fertilised pods corrected for flower number.

TABLE XVIII.

$b_2 = 0.365$

Strains	Mean flower x_1	$x_1 - \bar{x}$	$b_2 (x_1 - \bar{x})$	Mean number of pod x3	Rank	corrected number of pods	Rank.
401	38.5	—15.2	—5.55	12.3	vi	17.9	ii
402	53.2	— 0.5	—0 18	16.1	iii	16.3	iii
403	81.1	+27.4	+10 00	23.1	i	13.1	iv
404	57.3	+ 3.6	+1.31	14.1	iv	12.8	v
D8	52.1	— 1.6	—0.58	9.3	vii	9.9	vi
62	45.9	— 7.6	—2.85	13.5	v	16.3	iii
28	49.7	— 4.0	—1.46	17.8	i	19.3	i

Mean $\bar{x}_1$ —58.7.

It will be observed from the above table that the corrected number of fertilised pods for D8 is the lowest even after correction. No. 28 which was second in order, ranked first. No. 401 which was last but one in scale, ranked second and No. 403 which was first has been placed last in the rank. The general conclusions from the foregoing discussions are that—

(a) The proportion of fertilised pods to total number of flowers per plant is the highest for No. 28 and the lowest for D8

(b) That the higher number of flowers in general is associated with greater number of fertilised pods.

(3)

Effect of variable flower number on the number of total pods:—It has been pointed out previously that the unfertilised pods are related with flower number in only two strains D8 and 62 where as fertilised pods are associated with flower number in all the strains. It may therefore be interesting to know the relationship of total pods with covariance for these two attributes is given in the Appendix I.

The correlation between flower number aud total pod number based on 89 D F. works out to 0.84 which is significant. The significance is further tested by apportioning the sums of squares with 89 D.F. into that due to regress on and due to deviations from regression.

TABLE XIX.

Significance of regression (bet. plants)

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Regression	1	9562.21	9562.21	210.59	3.95	6.93
Dev. from regr.	88	3996.84	45.41			
Total	89	13559.05	152.34			

The mean square for total pods has now been reduced from 152.34 to as low a figure as 40.41. The variation in total number of pods is thus attributed to the differance in the flowers on each plant.

In the above analysis a general regression has been worked out by combining all the strains together. The validity of doing so is tested in the following two table.

TABLE XX.

Value of regression co efficient within strains.

(Flower and total pods)

Strains	D.F.	Sx^2_1	Sx1 x4	Sx^2_4	bS	Due to reg. bS (x1x4)	Sums of sq. due to Dev. from reg.	D.F.	Mean Sq. from dev. from reg	F
401	14	6367.75	2815.60	1548.75	0.445	1244.49	304.26	13	23.40	53.18
402	15	5083.55	2395.85	1929.95	0.471	1128.45	801.50	14	57.25	19.71

Strains	D.F.	Sx_1^2	Sx_1x_4	Sx_4^2	b3	Due to reg. b3 (x_1x_4)	Sums of sq due to Dev. from reg.	D.F.	Mean Sq. from dev. from reg	F.
403	11	14982.42	5470.75	2490.75	0.365	1996 73	494 02	10	49.40	49 40
404	15	7808.60	2008.10	1407 15	0.255	512 06	895 09	14	63.94	8 00
D8	11	4209.20	1215 20	553.20	0.288	349 97	203.23	10	20.32	17.22
62	9	7592.00	3301.00	1935.90	0.434	1432.63	492.72	8	61.59	28 26
28	14	15098 75	6976 35	3693.35	0.462	3223 07	470.28	13	36 17	89.10
Total	89	61141.67	24182,60	13559.05	0.395	9562 21	3671.65	88	41.72	23.93

x_1 = Flower.

x_4 = Total pods.

Test of significanee of the difference of the regression co-efficient for the different strains is indicated below:—

TABLE XXI.

Due to	D.F	Sums of sq.	Mean sq.	Obs.	F Calculated. 5%	1%
Mean regression	1	9562.21	9562.21	213.58	3 96	6 96
Dev. of variety regression from mean regression ...	6	325.19	54.18	1.21	2.21	3.04
Seven varity regr.	7	9887.40	1412.48	31.77	2.12	2.87
Dev from variety regression	82	3671.65	44.77			
Total	89	13559.05	152.34			

It will be observed that the value of 'b' for the different strains (table 20) are practically of the same order. Besides the deviations of variety regression from mean regression (table 21) is insignificant. It is therefore justifiable to work out a combined regression for all the strains.

Test of significance of varietal differance in respect of the number of total pods after allowing for the effect of variable number of flower:—The table of analysis of residual variance has been prepared in the usual way. The following results are obtained.

TABLE XXII.

Analysis of residual variance.

Due to	D.F.	Sums of sq..	Mean sq.	F Obs.	Calculated 5%	Calculated 1%
Variety Bet. Plant	94	4610.54				
Dev. from general regression	88	3996.84	45.41	2.23	2.20	3.02
Variety	6	613.70	102.28			

It is clear that the varietal effect is still significant after allowing for flower number.

Calculations of mean number of total pods corrected for flower number—b3-0.326.

Strains	Mean flower x_1	$x_1 - \bar{x}$	$b_3 (x_1 - \bar{x})$	Mean total pods	Rank	Corrected total pods.	Rank
401	38.5	—15.2	—6.01	13.66	v	19.67	ii
402	53.2	— 0.5	—0.19	17.47	iii	17.66	iii
403	81.1	+27.4	+10 82	25.86	i	15.04	v
404	57.3	+ 3.6	+1 42	16.00	ii	14.58	vi
D8	52.1	— 1.6	—0.63	12.46	vii	13.09	vii
62	45.9	— 7.8	—3.08	13 00	vi	16.08	iv
28	49 7	— 4.0	—1.58	18 86	v	20.46	i

, Mean $\bar{x}_1$ —58.7. Mean 17.02.

These results show that as in the case of fertilised pods properties of total number of flowers per plant is highest for No. 28 and lowest for D8 and that higher number of flowers in general results in the formation of more number of pods in all the strains.

(4)

Effect of variable flower number on the number of seeds per plant:—The relationship of these two factors is studied below. x stands for flower number and x4 for number of seeds. The analysis of variance and Covariance is given in the Appendix I.

The correlation between flower number and number of seeds based on 89 D.F. is 0.79 which is significant. The significance

can also be tested by apportioning the sums of squares in to that due to general regression and due to deviation from general regression.

TABLE XXIII

Significance of regression Flower number into seeds.

Due to	D.F.	Sums of sq.	Mean sq.	F Obs	5%	1%
Regression	1	8775.25	8775.25	146.62	3.92	6 93
Dev. from regr.	88	52₀6.42	5₅.05			
Total	89	14041.67	157.77			

The mean square for total number of seeds is now reduced from 157.77 to 59.85 Most of the variations in total number of seeds per plant, as in the case of fertilised pods, is thus attributed to the variable number of flowers on each plant.

The test to find out the validity of working out a general regression involving all the strains is carried out in the following two tables.

TABLE XXIV.

Value of regression co-efficient with strains.

(Flowers x Seeds)

Strains	D.F.	Sx_1^2	Sx1 x5	Sx_5^2	b4	Due to reg b4 (x1x5,	Sums of sq. due to Dev. from reg.	D.F.	Mean Sq. from dev. from reg	F.
401	14	6367 15	2802.15	1451 55	0.440	1232.95	218.60	13	16.81	73 40
402	15	5083.55	1048.75	1494.75	0. 06	307.92	1186.83	14	84.77	3.75
403	11	14982.42	5440.00	2574.50	0.363	1974.72	600.38	10	60.(3	32 89
404	15	7808.60	2369 60	2045 20	0.302	712 60	1332 60	14	95.18	7.48
D8	11	4208.20	844 80	403.45	0.201	169.80	233.65	10	23.36	7.26
62	9	7592.00	3059.00	1689.47	0.403	1232.78	456.69	8	57.08	21.59
28	14	15093.75	7599.40	4382.75	0.503	38_2.50	560.25	13	43.09	88.70
Total	89	61141.67	23153.70	14041.67	0.379	8775.25	5266.42	88	59.84	146.64

x1—For flower number.

x5—For seed number.

TABLE XXV.

Test of significance of difference of the regression co-efficient for different strains.

Due to	D.F	Sums of sq.	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Mean regression ...	1	8775.25	8775.25	156.81	3.96	6.96
Dev. of variety regression from mean regression ..	6	678.02	113.00	2 02	2.21	3.04
Seven variety regr. ...	7	9453.27	1350.47	24.13	2.12	2.87
Dev from variety regression	82	4588.40	55.96			
Total	89	14041.67	157 77			

It will be observed with the value of F that in all the varieties there is a significant correlation, but with varying intensity between flower number and number of seeds. The mean square due to seven varietal regression is significant The mean square with 6 D.F. representing deviation of varietal regression from mean regression although high, is not statistically significant, the value of 'F' falling short of that required at 5% level of significance The calculations of mean regression by combining all the strains is therefore justified.

Test of siguificance of varietal differences in respcet of the number of total seeds after allowing for possible effect of variable number of flowers.

The analysis of residual variance is shown in table 26.

TABLE XXVI.

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Variety bet. plant	94	6020.37				
Dev. from general regression	-88	-5266.42	59.85			
Variety	6	0753.95	-125.65	-2.11	2.20	3.02

It will be observed that the varietal effect on the number of seeds is not significant after allowing for variable flower number.

Calculation of mean number of seeds per plant corrected for flower number.

TABLE XXVII.

Strains	Mean flower x_1	$x_1 - \bar{x}_5$	$b3\,(x_1 - \bar{x}_5)$	Mean seeds x_5	Rank	Corrected seed number	Rank.
401	38.5	—15.2	—5 76	13.00	vi	18.60	ii
402	53 2	— 0.5	—0.19	15.73	iv	15.90	iv
403	81.1	+ 27.4	+ 10.38	25 53	i	15.10	vi
404	57 3	+ 3.6	+ 1.36	17.05	iii	15.70	v
D8	52.1	— 1.6	—0.61	10.60	vii	11 20	vii
62	45 9	— 7 8	—2.96	14.00	v	17.00	iii
28	49.7	— 4.0	—1 52	18.44	ii	20.00	i

Mean $\bar{x}1$—53.7 Mean x5 16 35.

It will be observed as in the case of fertilised pods that the order of 403 which before adjustment was first is now much low and that of 28 is first after correction. D8 stands lowest both before and after adjustment. The peculiar behaviour of 403 can be mainly attributed to the fact that it contains proportionately more number of nil seeded pods. The correlation of the two factors in general implied that more number of flowers result in more number of seeds.

(5)

Effect of variable pod number on the number of seeds per plant: The following study is undertaken to find out relationship of pod number on the number of seeds per plant. The analysis of variance and co-variance is given in the Appendix I.

The correlation between total number of pods and the number of seeds based 89 D.F. is 0.94.

By dividing the sums of squares with 89 D.F. into two componants, viz., due to regression and due to deviation from general regression we get as follows:—

TABLE XXVIII

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Regression	1	12307.74	12307.74	624.75	3.95	6.93
Dev. from general regression	88	1733.93	19.70			
	89	14041.67	157.77			

The mean regression for total number of seeds has now been reduced from 157.77 to as low figures as 19 70. The variation in the total number of seeds is thus due to variable number of pods on each plant.

The validity of working out a general regression for all the strains has been tested in the following two tables.

TABLE XXIX

Test of significance of the difference of the regression co-efficient for different strains.

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Mean regression	1	12307.74	12307.74	682.24	3.96	6.96
Dev. of varietal regr. from mean regr.	6	254.30	42.38	2.34	2.21	3.04
Seven Variety regression	7	12562.04	1794.57	99.47	2.12	2.37
Dev. from variety regression	82	1470.63	18.04			
	89	14041.67	757.77			

It will be observed that the mean square with 6 D.F. representing deviation of varietal regression from mean regression is significant exceeding 5% level. It is therefore not justifiable to calculate mean regression by combining all the strains It has got to be calculated for each strain separately. This is also indicated by the study of the different values of F for the different strains in table 30. All the values though significant are not of the same

order but show a very wide range of variation from 11.29 in the case of 402 to 2437.8 in No. 28.

TABLE XXX.

Values of regression co-efficient within varieties (Pod No. x Seed).

Strains	D F.	Sx_4^2	$Sx_4 x_5$	Sx_5^2	b5	Due to reg b5 (5x4x5)	Dev. from reg.	D F.	Mean Sq. from dev. from reg	F.
401	14	1548.75	1485 40	1451 55	0.95	1411.13	40.42	13	3 10	445.20
402	15	1929.95	1141.25	1494.75	0.58	661.92	832.83	14	59.48	11.29
403	11	2490.75	2463.75	2574.50	0.91	2442.01	332.49	10	33.24	73 46
404	15	1407.15	1621 10	2045 20	1.15	1864.76	180 94	14	12.92	144.30
D8	11	553.20	434.00	403.45	0 78	338 52	64.93	10	6.49	52.16
62	9	1935.90	1801.20	1689.47	0.93	1675.12	14.35	8	1.79	936 04
28	14	3693.35	4008.70	4382.75	1.09	4359 48	23.27	13	1.78	2437.89
Total	89	13559.05	12955 52	14041.67	0.95	12307 74	1734.93	88	19.71	624 99

x4—For Pod number.

x5—Seed number.

It is therefore quite clear that pod number is correlated with number of seeds but with varying intensity. The values of F clearly point out this behaviour of the various strains under study.

(6)

Effect of variable flower number on the yield of grain per plant:—Yield is the ultimate produce which is of economic importance and it is useful to study how it is associated with flower number. The analysis of variance and covariance for these two characters are given in Appendix I.

The correlation between flower number and yield per plant based on 89 D F. comes to 0 59 which is significant. The list of significants as studied by apportioning the sums of squares for 89 D.F. in two parts is given below:—

TABLE XXXI.

Significance of regression

Due to	D.F.	Sums of sq.	Mean sq.	F Obs	F Cal. 5%	F Cal. 1%
Regression	1	63.54	63.54	37.3	3.95	6.93
Dev. from regr.	88	87.88	0.28			
Total	89	151.42	1.70			

It will be observed from the above that, in general, there is a dependence of grain yield on flower number. The variance due to regression is significant even at one per cent level of significance.

The test to ascertain the validity of grouping the different strains together and calculating a general regression is carried out in the following two tables.

TABLE XXXII.

Due to	D.F	Sums of sq	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Mean regression	1	60.54	63.54	69.06	3.96	6.96
Dev. of varietal regression	6	12.52	2.08	2.26	2.21	3.04
Seven variety regr.....	7	76.06	10.87	11.81	2.12	2.87
Dev. from varietal regression	82	75.36	0.92			
Total	89	151.42				

TABLE XXXIII.

Value of regression co-efficient within Varieties (flower number x yield)

Strains	D.F.	Sx_1^2	Sx_1y	Sy^2	b_8	Due to reg. b8 (Sx1 y)	Dev. from reg.	D.F.	Mean sq. Dev. from reg.	F
401	14	6367.15	220.66	18.98	0.034	7.50	11.48	13	0.806	9 37
402	15	5083 55	299 38	31 35	0.058	17.36	13.99	14	0.990	14.13
403	11	14982 42	516.19	28.52	0.030	15.39	13.03	10	1.303	11.83
404	15	7808.60	139.21	11.14	0.018	2.50	8.64	14	0.617	4.09
D8	11	4209.20	82.74	4.75	0.019	1.57	3.18	10	0.318	5.06
62	9	7592 00	101 72	7.52	0.013	1 32	6.20	8	0.775	1.71
28	14	15098.75	758.10	49.16	0 040	30.32	18 84	13	1 450	20 91
Total	89	61141.67	2118 00	151.42	0.34	63.54	87.88	88	0.990	64.08

x for flower number.
y for yield.

It will be observed that mean square with 6 D.F. representing deviation of varietal regression from mean regression just exceeds 5% level of significance. The calculation of mean regression by combining all the strains is therefore not justifiable. The regression has got to be calculated for each variety separately. It will be observed from table 33 that in all the strain except No. 62 the regression effect is significant.

It is quite evident from the above table that the mean square due to regression is not significant as compared to mean square due to deviation from regression for the strain No. 62 while that for 404 and D8 just exceeds the 5 per cent level of significance. In the case of other strains it exceeds 1 per cent level of significance. As has been observed previously, othere is a positive correlation between flower number and nil seeded pods in the case of D8 and 62; but the per centage of two seeded pods in higher in D8 than in 62, i.e., 11.3 as against 1.2 which explains for the existence of correlation between flower no. and yield in D8. From the above analysis it can be concluded that more number of flowers tend to produce higher grain yield per plant. This association is not properly expressed in 62 mainly due to high per centage of sterility and also due to the higher per centage of single instead of double seeded pods exhibited by the strains.

(7)

Effect of variable pod number on the yield of grain per plant:— As with the flower number the relationship of grain yield with number of pods would be useful. The correlation has been studied on the same lines and is given below. The analysis of variance and co-variance is given in appendix I.

The correlation between pod number and yield based on 89 D. F. works out to 0.93 which is significant.

By apportioning the sums of squares into two component we get—

TABLE XXXIV.

Significance of regression (bet. plants).

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Regression	1	101.713	101.70	59.13	3.95	6.93
Dev. from regression	88	49..13	0.56			
	89	151.420	1.72			

The mean square for weight of seed is much reduced from 1.72 to 0.56. Most of the variation in total weight of seed per plant is thus attributed to the variable number of pods on each plant.

The question whether the average regression can be taken as the best estimate of regression of plant yield on pod number is studied in the next two tables.

TABLE XXXV.

Values of regression co-efficient within varieties (Pod No. x Yield)

Strains	D F.	Sx^2_y	$S\ 4\ xy$	$S\ ^2_y$	b7	Due to reg. b7 (Sx4 5)	Dev. from reg.	D.F.	Mean Sq. dev. from reg	F.
401	14	1548.75	159 73	18 98	0.10	15.97	3.01	13	0.23	69.43
402	15	1029.95	237.77	31.35	0.12	28.53	2 82	14	0.20	142 65
403	11	2490.75	215.25	28.52	0.09	19.37	9.15	10	0.91	21.21
404	15	1407.15	41 86	11.14	0.03	1.26	9.89	14	0.70	1.78
D8	11	553.20	44.20	4.75	0.08	3.54	3.21	10	0.12	29.50
62	9	1935.90	65.76	7.52	0.03	1.97	5.55	8	0.69	2 85
28	14	3693.35	395.21	49.16	0.19	39.52	9.64	13	0.74	53.40
Total	89	13559.05	1159.78	151.42	0.88	101.713	49.71	88	0.56	181.62

x4—For Pod number

y—yield.

Test of significance of the difference of regression coefficient for the differant strains from the mean regression is carried out in she following table.

TABLE XXXVI.

Due to	D.F	Sums of sq.	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Mean regression	1	101.713	101.713	203.42	3.96	6.96
Dev. of varietal regression from mean regression	6	8.450	1.408	2.80	2.21	3.04
Variety regression	7	110.163	15.73	31.46	21.12	2.87
Dev. from regression.	82	41.260	0.50			
	89	151.420	1.70			

Since the variety regression from mean regression is significant it would be incorrect to regard the average regression as the best estimate of regression of yield on pod number. Mean square due to seven variety regression is also significant.

It can therefore be summarised that the increase in the number of pods results in increased grain yield in all the strains under study except in the case of 404 and 62.

(8)

Effect of variable seed number on the yield of grainx per plant :—

The relationship of grain yield with total No. of seeds per plant has been studied below. The analysis of veriance and co-variance have been given in the appendix I.

The correlation between seed number and yield per plant based on 89 D.F. comes to 0.81. The significance of regression as carried out by the alternative procedure gives—

Significance of regression

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Regression	1	98.93	98.96	58.21	3.95	6.93
Dev. from regr.	88	52.46	0.64			
Total	89	151.42	1.70			

The mean square due to regression being significantly higher than the mean square due to deviation from regression establishes the fact indicated above that grain yield is associated with number of seed per plant.

The following two tables have been formed to see if it is correct to work out a general regression by combining all the strains.

TABLE XXXVII.

Value of regression co-efficient within Varieties (Seed number x yield)

Strains	D.F.	Sx_5^2	Sx5 xy	Sy^2	b_8	Due to reg. b8 (Sx 5y)	Dev. from reg.	D.F.	Mean sq. Dev. from reg	F.
401	14	1451.55	161.86	1898	0.14	17.97	1.01	13	0.07	256.71
402	15	1494.75	153 95	31.25	0.102	15.70	15.55	14	1.11	14.14
403	11	2574 50	230.91	28.52	0.089	20.55	7.97	10	0.79	26.01
404	15	2045.20	138.56	11.14	0.067	9.28	1.86	14	0.13	71.38
D8	11	403.45	29.41	4.75	0.072	2.12	2.63	10	0.26	8.15
62	9	1689.47	40.78	7.52	0 074	0.97	6.55	8	0.81	1.19
28	14	4382.75	426.17	49.16	0 097	41.34	7 82	13	0.60	68 90
Total	89	14041.67	1181.64	151.42	0.084	98.96	52.46	88	0.59	167.78

x5 for number of seeds.

y for yield.

Test of significance of differance of the regression co-effieient for the different varieties :—

TABLE XXXVIII.

Due to	D.F.	Sums of sq.	Mean sq.	F Obs.	F Cal. 5%	F Cal. 1%
Mean Regression	1	98.96	98.96	186 71	3 96	6.96
Dev. of varietal regr. from mean regr.	6	8.97	1.49	2.81	2.21	3.04
Seven Variety regression	7	107.53	15.07	29.07	2.12	2.87
Dev. from variety regression	82	43.49	0.53			
Total	89	151.42				

The deviations of varietal regression from mean regression is significant at 5% level aud suggests that grouping of the strains to get a general regression is incorrect. The seven variety regression is also significant. But it can be seen from the F values of

different strains (table 37) that the significance of regression is not shown by strain No. 62 while in others it exists with a wide range of intensity.

Summary and conclusion:—The correlations of number of flowers with number of unfertilised pods, number fertilised pods, total number of pods and seeds per plant and of pods with seed, flowers with yield, pods with yield and seeds with yield per plant in seven strains of C. P. grams have been studied in the present investigation.

The data are collected on a varietal trial of gram conducted in the area of second Economic Botanist C. P. Nagpur.

Five plants were selected at random in each plot and were kept under observation for number of flowers, empty pods, fertilized pods, one seeded and two seeded pods, total number of pods, number of seeds and weight of seeds per plant.

The mean number of flowers per plant for the different strains show a wide range of difference from 38.5 to 81.1 with an average of 53.7. The differences amongst the different strains are significant.

The differences amongst the different strains with reference to fertilized pods, one seeded and total pods are not significant The different strains, however, show a significant difference in the formation of their unfertilized pods, strain No. 403 containing the maximum number of empty pods e.g. 3 5 per plant and No 62 the least e.g. 0.4.

The different strains exhibit significant differences in the formation of total seeds per plant but the average weight of seeds per plant does not differ significantly for each other in the different strains, strain No 492 shows the weight of 1.8 grams per plant and D8 giving least of 1.1 gram. Thus it will be seen that although strain No. 403 and the highest number of nill seeded pods, because it contains proportionately more number of one seeded pods, scores in the end and has highest number of seeds per plant. There is no correlation between flower number and unfertilised pods except in D8 and 62. Flower number and fertilised pods are however fully correlated in all the strains, the combined value of "r" for all the strains being 0.805 which is

significant. Similarly flower number and total pods per plant are completely correlated, the value of 'r' for such relation being 0.84 for all the strains. A positive correlation has also been found out between flower number and seeds per plant in all the strains. The 'r' value for such relation is 0.79.

The study of the effect of variable pod number on the number of seeds per plant has indicated a positive significant correlation between the two factors in all the strains except strain No. 62 which shows a high % sterility and preponderence of single instead of double seeded pods.

Similar observations have also been noticed in the study of pod with yield and seed with yield where strain No. 62 has shown absence of correlation in the two factors although in the rest of the strains a positive significant correlation was obtained.

These findings have a direct bearing on selection work. They indicate the inadequateness of working for number of flowers alone which makes selection and suggests the necessity to see that the pod formation is free from sterility. Then are mostly constituted of two seeded ones.

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P. T. O. Appendices—I & II.

Appendix 1.

Analysis of Variance and Co-variance.

Due to	D. F.	Flower $x1^2$	Nil seeded pod $x2^2$	Fertilised pods $x3^2$	Total pod $x4^2$	Total seed $x5^2$	Weight of seed y2	Flower x Nil seeded x1 x2	Flower x fertilised pods x1 x3	Flower x total pods x1 x4	Flower x seeds x1 x5	Flower x yield x1 Y	Total pods x seeds x4 x5	Total pods x yield x4 Y	Total seeds x yield x5 Y
Blocks	3	3694.95	29.27	1039.50	1408.85	667.91	16.39	280.47	1480.39	2160.50	1485.60	279.58	916.59	106.87	71.47
Varieties	6	16781.11	59.38	1801.11	1726.93	2130.20	8.24	589.00	3542 83	4662.77	4974.93	168.66	1926.84	136.84	155.29
Error	18	13098.39	55.91	3181.74	3284.70	4742 86	51.20	180.36	5583.27	6265.61	5452.70	688.89	3661.00	384.48	434.83
Between plants	89	61141.67	353.37	12610.15	13559.05	14041.67	51.42	1338.65	22343.40	24182.60	23153.30	2118.00	12955.52	1159.78	1181.64
Between plants+ Varities	95	77922.78	412.75	14411.28	15285.98	16171.87	159.66	1927.65	25886.23	24844.79	28128.23	2286.66	14882.36	1298.56	1336.93
Error+ Varieties	4	29879.50	115.29	4982.85	5011.63	6873.06	59.44	769.36	9126.10	9927.78	10427.63	857.55	5537.84	521.26	590.12

b1	b2	b3	b4	b5	b6	b7	b8	b1 x x1 x2	b2 x x1 x3	b3 x x1 x4	b4 x x1 x5	b5 x x4 x5	b6 x x1 Y	b7 x x4 Y	b8 x x5 Y
....	....	....	....	....	0.075	0.760	....	....	....	....	....	....	20.97	0.088	....
0.035	0.211	0.278	0.298	1.116	0.010	0.790	0.049	20.61	747.54	1205.15	1473.97	2149.77	-1.69	10.833	7.61
0.013	0.426	0.402	0.416	1.149	0.052	0.120	0.091	2.84	2378.47	2116.77	2268.32	4067.37	35.82	46.510	39.56
0.021	0.365	0.395	0.379	0.955	0.034	0.880	0.084	28.11	8164.95	9562.21	8775.25	12007 74	63.54	101.710	98.96
0.024	0.332	0.370	0.361	0.973	0.029	0.850	0.082	46.02	8592.48	10675.44	10151.50	12691.55	66.31	109.950	109.6
....	0.305	0.332	0.349	1.114	0.029	0.110	0·085	....	2783.46	3296.02	3539.24	6224.85	24.87	54.210	50.16

Appendix II.

Plant No	401: 1	2	3	4	5	6	7	402: 1	2	3	4	5	6	7	403: 1	2	3	4	5	6	7
1	33	16	...	1	17	16	2.37	60	4	2	2	8	8	0.30	18	4	....	2	6	4	0.40
2	112	46	1	4	51	48	5 10	45	14	4	.2	20	22	1.20	126	33	6	2	41	45	4.40
3	....	....	....	....	....	..	....	46	1	....	...	3	3	0 35	70	11	....	8	19	11	1.40
4	42	3	3	3	9	9	1.00	106	37	1	3	41	39	4.45	...	...	....	....	....	....	....
5	61	31	....	5	36	31	3.86	43	12	0	5	17	12	0.95	82	5	3	7	15	11	1.20
6	25	7	....	3	10	7	0 41	43	14	3	...	17	20	1.75	....	....	....	....	....	....	....
7	29	2	..	1	3	2	0.16	62	4	2	2	8	8	0.55	95	23	2	3	28	27	2.65
8	25	10	1	..	11	12	1.65	50	20	3	...	23	26	2.95	99	37	2	7	46	41	3.05
9	42	16	...	....	16	16	2.47	59	21	5	....	26	31	3.15	49	7	2	...	9	11	1.01
10	16	3	....	1	4	3	0.20	36	2	1	1	4	4	0 15	72	17	1	1	19	19	2.25
11	32	8	....	1	9	8	1.20	54	6	3	2	11	12	0.65	129	37	2	3	42	41	3.15
12	22	3	....	1	4	3	0.17	30	9	....	...	9	9	0.45	123	30	....	1	31	30	4.05
13	17	2	....	....	2	2	0.12	38	7	6		13	19	1.95	132	44	4	2	50	52	5.40
14	17	9	....	....	9	9	0 95	49	14	3	1	18	20	1.85	....	...	...	....	....	...	....
15	30	7	1	1	9	9	1.35	55	18	1	2	21	20	2.15	34	4	3	....	7	10	0.50
16	....	....	....	....	....	....	....	73	21	10	1	32	41	3.90	67	18	8	2	28	34	2.00
17	48	7	1	3	11	13	0.97	37	4	....	....	4	4	0.15	80	23	2	2	27	27	0.50
18	71	23	1	....	24	25	2.63	80	32	1	3	36	34	4.00	....	....	....	....	....	...	....
19	11	....	....	1	1	....	....	....	....	....	...	....	....	....	41	16	2	2	20	20	2.75
20	61	19	....	....	20	21	2.28	5	18	3	...	21	24	2.70	....	....	....	....	....	....	....
	694	212	9	25	246	234	26.89	1101	258	49	25	332	356	33.60	1217	309	39	42	388	383	33.65

Plant No	404: 1	2	3	4	5	6	7	D.8: [1]	2	3	4	5	6	7	62: 1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	....	....	....	....	...	....	....	[illegible]	...	...	....	....	...	....	....	....	....	...	....	....	...	54	18	...	....	18	18	1.20
2	93	30	3	1	34	36	2.90	[illegible]	8	1	3	12	10	1.09	34	21	1	...	22	23	2.10	172	75	4	...	79	83	8.30
3	44	12	3	1	16	18	1.45	[illegible]	....	....	...	....	....	....	13	7	...	....	7	7	0.70	68	24	....	...	24	24	4.50
4	60	14	1	2	17	16	0.40	[illegible]	3	....	....	3	3	0.40	73	38	1	4	43	40	0.77	41	3	1	7	11	5	0 30
5	49	8	....	4	12	8	0.75	[illegible]	....	....	....	...	....	....	72	22	....	2	24	22	1.62	42	23	2	2	27	27	2.90
6	38	15	...	1	16	15	0.90	[illegible]	8	....	1	9	8	1.20	...	....	....	...	....	....	....	....	....	...	....	....	....	...
7	46	7	1	2	10	9	0.85	[illegible]	2	....	2	4	2	0.35	22	1	....	2	3	1	0.12	27	3	....	2	5	3	0.40
8	53	2	....	1	3	2	0.25	[illegible]	....	....	....	....	....	....	....	...	....	...	....	....	....	16	12	....	....	12	12	1.70
9	102	24	11	2	37	46	3.00	[illegible]	5	1	4	10	7	0.59	...	....	....	...	....	....	....	59	26	....	1	27	26	2.70
10	36	10	3	1	14	16	1.15	[illegible]	8	3	7	18	14	1.20	...	....	....	....	....	...	....	47	13	1	3	17	15	1.20
11	74	2	...	...	2	2	0.20	[illegible]	27	1	5	33	29	3.40	16	4	....	1	5	4	0.32	36	...	1	2	3	2	0.10
12	63	12	7	5	24	26	2.20	[illegible]	9	....	....	9	9	1.14	31	7	....	...	7	7	0.52	31	5	1	..	6	7	0.80
13	27	3	1	....	4	5	0.50	[illegible]	14	1	5	20	16	1.60	53	10	....	...	10	10	0 54	66	24	....	....	24	24	2.80
14	25	8	1	1	10	10	1.20	[illegible]	....	....	...	....	....	....	41	2	....	3	5	2	0.20	48	18	....		18	18	1.80
15	39	....	2	...	2	4	0.35	[illegible]	16	4	1	21	24	2.80	69	11	....	...	11	11	0.80	20	3	....	1	3	3	0.10
16	60	13	7	...	20	27	1.90	[illegible]	3	3	1	7	9	0.40	36	8	....	...	8	8	0.70	25	8	1	..	9	10	1.20
17	99	15	4	8	27	23	1.20	[illegible]	10	2	7	19	14	1.60	102	37	4	7	48	45	4.00	36	16	....	1	17	16	2 00
18	72	7	6	....	13	19	1.70	[illegible]	2	2	1	5	6	0.60	....	....	....	....	....	....	....	55	14	...	1	15	14	1.70
19	53	17	5	3	25	27	1.90	[illegible]	6	....	5	10	5	0.50	...	....	....	....	....	....	....	....	....	....	....	....	....	....
20	53	11	2	5	18	15	1.40	[illegible]	1	1	5	7	3	0.20	30	2	....	...	2	2	3.20	52	25	....	....	25	25	2.60
	1089	210	57	37	304	324	24.20	[illegible]	121	19	47	187	159	17.33	597	170	6	19	195	182	15.59	895	310	11	20	341	332	36.30

1 — Flower Number
2 — One seeded pods
3 — Two " "
4 — Nil " "
5 — Total pods
6 — Total seeds
7 — Weight of seeds in gms

1 — 5 Ist replication
2 —10 IInd "
3 —15 IIIrd "
4 —20 IVth "

Varietes:—

1 401
2 402
3 403
4 404
5 D. 8
6 62
7 28

Manuring of the Nagpur Santra Orange

By

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Quite a large number of orange orchards in the Central Provinces and Berar are in poor condition due to under nourishment and hardly produce a few hundred fruits per tree as compared to some of the well maintained orchards where the average yield per tree is well over one and a half to two thousand fruits. Not only the under nourished trees bear light crops of fruit but their productive life is greatly shortened.

Large quantities of the various food nutrients are drawn from the Soil annually by the orange tree for its growth and production of fruit and unless food supply is adequately replenished the tree is rendered weak and unproductive. If food supply is withheld continuously for a long time the leaves turn pale yellow and folliage is considerably reduced, followed by drying up of shoots and main branches. Such undernourished trees tend to flower profusely but only a very small crop of undersized worthless fruit is carried to maturity. The aim of this article, therefore, is to indicate the manurial programme that should be followed to obtain continued good cropping during the productive life of the orange tree.

Food Nutrients Required:–There are various food elements which are essential for healthy growth and optimum fruiting of the orange tree and these are classified into two main groups. The first group constitutes major elements such as nitrogen, Phosphoric acid, potash and lime which are required by the tree in great quantities. The second group includes minor, trace or micro elements such as magnesium, iron, manganese, copper, boron and zinc etc. which are required by the tree in very small amounts although their absence leads to many physiological disorders. Unless actual experiments are conducted on the Nagpur Santra tree to find out deficiencies of the minor elements it is not possible to make any

recommendation with respect to these. But to show the importance of these elements an example is quoted. Lack of boron in the soil causes disorder in citrus trees which is characterised in severe cases by extreme defolliation, death of terminal shoots resulting in die back and the development of small leaves with tiny dents on the upper surface of the leaves. The bulk of the crop is shed very early and the remaining fruit is misshaped and unfit for consumption. Gum packets or corky patches occur throughout the fruit and the juice is absent to a large degree.

Major Elements:-Out of the four major elements mentioned above already, lime and potash are in sufficient quantity in the C. P. Soils and there is no liklihood of these becoming limiting factors. Phosphoric acid on an average comes to about 0.03, varying from 0.05 to 0.1 per cent There does not seem to be any necessity of this element also as it has been found in various citrus growing countries, especially in America, that in soils where the phosphoric acid content is near about 0.08 per cent, Citrus trees do not respond to the application of this element in the soil.

It is obvious, therefore, that the only food nutrients required by the orange tree in a large quantity is nitrogen and until such time as the deficiency of other food elements in C. P. Soil are experimentally proved, attention should be paid to the application of nitrogenous manures only.

Nitrogenous Manures :—By far the best nitrogenous manures for the orange tree are organic ones like farm yard manure, farm and town composts. At places where these organic manures are not available in sufficient quantity half of the total nitrogen requirements can be substituted by inorganic source such as ammonium sulphate. Continued use of inorganic nitrogenous fertilizers alone leads to mottle leaf, drying of the tips of shoots and low productivity.

Quantity to be Applied:—Manurial requirements of the orange tree varies according to the age of tree, kind of soil and the amount of fruiting etc. and therefore it is not possible to suggest a definite manurial programme for the orange tree growing under varied conditions of soil. The following table, however, shows the amount of manures which should be applied under average conditions obtaining in the Central Provinces and Berar.

Quantity of Manures in Lbs.

Manures	Age of Trees in years											
	1	2	3	4	5	6	7	8	9	10	11	12
Farm yard manure or composts alone	20	30	50	80	100	120	140	160	180	200	220	240
Farm yard manure or composts	10	15	25	40	50	60	70	80	90	100	110	120
Plus Ammonium Sulphate	1/4	3/8	5/8	1	1¼	1½	1¾	2	2¼	2½	2¾	3

Note.—The above figres are based on the assumption that farm yard manure and composts contain on an average 0.5 per cent of available nitrogen.

Method of Application:—The general local practice is that manure is applied an irrigation pit which does not extend to more than 2-2½ feet around the trunk of a grown up tree. As the feeding roots of an orange tree extends to its perephery or even beyond, manures should be applied in such a manner that most of the feeding zone is covered and the roots are able to utilize the maximum amount of manure added to the soil, for this purpose a shallow basin around the trunk of a tree should be prepared which should extend to its perephery, leaving 1½ feet space immediately around the trunk undisturbed which should be raised to an height of about 1 foot from the ground level by means of lighter type of surface soil. The soil enclosed by the basin should then be dug up to a depth of 6 to 8 inches and manure evenly spread in this area and well incorporated in the soil. In digging up the soil care should be taken to avoid injury to the roots. Before application ammonium sulphate should be powdered and mixed with soil twice or thrice its weight to ensure even distribution of the fertilizer in the basin. Irrigation should be grown immediaty after the manures are applied.

Time of Application:—For the " Ambia Bahar " crop farm yard manure or composts should be applied by the beginning of December, Ammonium Sulphate should be applied in two equal doses, once three weeks before flowering and then after the fruit set. For "Mirg Bahar" crop organic manures should be applied by the middle of June, after the first shower of rain. Ammonium sulphate should be applied in two doses before flowering and after fruit setting as explained for " Ambia Bahar", crop.

Some Thoughts on Yield

(Article by H. M. L. reproduced from International Sugar Journal, Vol. XLVI, No. 551, 1944.)

Few economic questions are simple and, most certainly, the economics of crop production is not one of those few. It would not be unfair to say the standard measure of success in improved cultural methods, in the production of new varieties and so is yield. That, however, is a preliminary step only; experiments can show only the potentialities of any proposed change in the standard agricultural practice. There remains the question of whether that change can be made without incurring additional charges which will more than offset the value of the increased yield. The work of the agrobiologists illustrates the point very clearly. They have shown that there is in each plant an inherent capacity to yield; that is, a capacity which will not be exceeded in the perfect environment when each and every environmental factor affecting plant growth is optimum. But they also show that each successive increment in any particular factor, say amount of nitrogen, produces a smaller effect when measured as yield. The time soon comes, therefore, when the cost of the added dose exceeds the value of the increase obtained as the result of the application.

Another pertinent point arises from a consideration of the theory of limiting factors. Plant growth, and with it yield, is limited by that factor which is in least supply. However many of the factors are present in optimum amount, if only one is deficient, growth and yield will be determined by that factor. It is useless, for instance, to evolve and introduce into general cultivation a new variety of a crop of which the inherent capacity to yield is greater than that of the standard crop, without considering the conditions of growth. Unless these are simultaneously improved, so increase will be obtained and the greater inherent capacity will remain potential. A good example of this is to be seen in India. The statistical returns for wheat in northern India show that the average yield is still the same as at the beginning of the century—as a matter of fact the average for the last quinquennium for which returns are available is slightly less (by an amount, however which is not statistically significant) than the average for the first quinquennium of the century. This is the result of forty years of

evolution of new varieties by the plant breeder A succession of new varieties has been introduced in cultivation and these undoubtedly have a capacity to produce yields much higher than the standard wheats earlier grown, but that capacity has remained potential and will only be realized when the conditions under which they are grown are improved The limiting factor lies in the soil But the soil itself is a complex of different factors, physical, chemical and biological, improvement of any one of which may influence yield little or not at all, for the limiting factor may lie in one of the other factors involved Progress will result only from a balanced and synchronized study of agriculture in all its aspects, it will result from team work, and concentration on one aspect is likely to result in much wasted effort The division of the sciences into the different and almost water tight compartments of the various "ologies" is not the most promising basis for the improvement of so complex a subject as agriculture

Such are the thoughts that arise from consideration of the subject of yield in its technical aspect, but they are merely of a preliminary nature Given, as the result of technical investigation in all the above directions, evidence to suggest that certain modifications in agricultural practice, in the widest sense of that phrase, are desirable the question arises as to how these modifications may best be introduced into general farming practice The nature of this problem may best be illustrated by a particular instance for which, for concordance's sake, the same example as above, drawn from India, may be taken There is here no question of an unbalanced technical study of wheat in northern India with emphasis on breeding as much attention has been given to the soil and conditions of growth of the wheat plant as to breeding Yet no appreciable increment of the general yield has resulted The cause lies, not in the technical work but in failure to apply its teaching to practice. When the reason for this failure is sought, it is found to lie in the economic organization of the industry That organization is on a peasant basis with small holdings varying from 2 5 to 5 acres, with high indebtedness and an absence of fuel which compels the peasant to use most of his cattle droppings as a substitute The peasant, or RYOT, has not the facilities for intensive cultivation, nor the means to purchase either fertilizers or the

fuel which would liberate organic matter by which the hummus content of the soil could be raised. The question of yield, thus, is directly linked with the question of the terms under which the land is held. It is primarily a question of land tenure, yet—if memory serves aright—land tenure being a revenue subject was specifically excluded from the terms of reference of the Royal Commission of Agriculture which made its investigations shortly after the last war. Of the technical services working under such conditions it might almost be said that, through no fault of their own, PARTURIUNT MONTES ET NASCITUR RIDICULUS MUS. What is lacking, in fact, is not knowledge but the means to turn knowledge to practice; what is wanted in the immediate conditions is, not more knowledge but the application of existing knowledge. If the division of the "-ologies" each working in a separate water-tight compartment is one source of weakness, the sum of the "-ologies," technology as a unit, may be equally ineffective as a water-tight department divorced from the economic conditions attaching to the practice of agriculture. The present writer was, as head of an Agricultural Department and Member of the Legislative Council of a Province of northern India, compelled to defend his Department against criticism on the grounds that the demonstration farms did not pay. The defence was easy; his own farm as a subordinate member of the service had always paid. But that was a misdirected criticism; they were made to pay because of the financial freedom conferred by their ownership, a freedom which allowed methods to be adopted which were entirely beyond the capacity of the small peasant. It did not follow that the peasant, lacking that financial freedom, could adopt the same methods. The influence of this freedom is, perhaps, best seen where the two systems, peasent and plantation, are closely intermingled. Such is particularly Trinidad with its cane farming. Here it is estimated that the difference between plantation and peasant yield is 6 tons per acre on plant cane (1933 figures, 30 tons and 24 tons respectively) and 4 tons per acre on ratoons (20 tons and 16 tons respectively). The conclusion to be drawn from such facts is that there is available the technical knowledge largely to increase the yield of crops; the difficulty lies in the application of that knowledge. The almost inevitable conclusion is that agriculture, in as far as yield is concerned, must be organized in units sufficiently large and of sufficient financial strength to render the application of technical knowledge feasible

in practice. As that may appear to be an argument in favour of the plantation system, it may be as well to issue a caution. It is not necessarily so; there are examples both of cooperative association of peasant units providing the necessary financial basis and of large-scale units (plantations) with the area distributed among a host of peasant tenures. Denmark offers an example of the former, and Fiji and the Sudan of the latter, and the degree of success depends apparently on the extent to which the spirit of co-partnership is incorporated into the scheme.

That point, the nature of the financial organization, cannot be discussed here; it has already been briefly considered earlier (1). A full study of the various systems adopted would show the importance of the role of finance in determining organization for agricultural production. There remains, however a further point; the nature of the technical advice which the provision of financial facilities would render available. The basis of technical advice is research and is commonly divided into two; pure and applied. The difference between the two is readily defined; the former is elusive in its aims and the worker moves research towards an unknown goal, in the latter, the goal is a solution to a specified practical problem. But, if definition is easy, practical distinction between the two is difficult for they merge into each other. Rarely is it possible for any organization working on commercial lines with its financial limitations to finance pure research; that is rhe work of a University. The practical problem is to draw the line between that research which is properly the function of a University and that which so directly affects practice that the commercial organization may be justified in incurring the expense of carrying a technical staff as an overhead. There is sufficient evidence in the methods by which the answer to this problem has been sought in different countries, to provide a broad conclusion.

In industry, only the largest units have found profit in entering the field of pure research; the financial risks are too great. The tendency has been, therefore, to leave such work to the universities or to Government frequently working through hybrid bodies, Research Associations, controlled by Committees composed of representatives partly of the industry and partly of Government. Experience in England since the last war, when the latter method received a great impetus, has failed to provide a solution of the problem, as

is evidenced by the present cry for a closer association between research and industry. It would seem that the research worker is a wayward individual, always drifting along the path of inclination and unwilling to be bound by a limited practical objective. The failure of these methods appears to lie in the non-recognition of this waywardness. The worker in pure research is an essential element in industrial progress; it is in the course of his meanderings that are brought to light those deeper secrets of nature which may be turned to practical account. But his is not the temperament to follow these bypaths to their practical conclusion. For this different temperament is required and a different training; a training in technique and a technical knowledge which will enable him to grasp the openings presented by the newer knowledge. But it is a temperament which requires a restraint which will counteract the desire, inherent in all, to a follow their inclination, and all the evidence points to the conclusion that this restraint is best applied by making these "interpreters of research" responsible to the industry alone. This thought envisages industry as organized into units sufficiently large to carry a technical staff responsible to, and paid, by the industry itself. The distinction, too little recognized, lies between the research worker, following his bent and having an assured income such as is provided by a University, and the "interpreter" paid by his capacity to "deliver the goods".

The world's sugar industry is carried on under very divergent conditions in the different areas in which sugar cane is grown and, for many decades, the agricultural aspect of cane cultivation has been the object of scientific study of growing intensity. A practical, if not perfect (for it leaves out cost) measure of the success of science in improving cane cultivation is yield and a comparison of the increases of yield per unit of area obtained under the different conditions should offer evidence of the efficiency of the different ways in which attempts have been made by the respective industries to take advantage of scientific knowledge. Unfortunately the records of yield for many of the countries involved are not available or lack concordance, but their are sufficient to justify a tentative conclusion. The collected data are too extensive to be given here but attention is at once attracted to three countries, Java, Hawaii and Fiji; all three are countries in which the industry maintains at its own expense a technical staff to supervise cultivation.

The facts of the Java industry have recently been reviewed (2); there has been a ten-fold increase of yield since the start of the industry as an independent organization in 1870. The increase has been especially marked in recent years, yield in quintals sugar per hectare rising from below 1,000 about 1920 to some 1,400 when war broke out. That review gives an idea of the work carried out by the extensive staff of "interpreters" employed and paid for by the industry. Hawaii entered the fiield much later but has built up a technical service, responsible to the industry. Like Java, it maintains a central experiment station which works in close collaboration with estate-staffs. Unlike Java, the estates have permanent possession of the land they cultivate. The yield per hectare, 1909-10 to 1913-14, averaged 930 quintals; in only one year before 1923/24 did it exceed 1,000 quintals and, from that date it has consistently risen to reach some 1,6000 quintals.

The conditions in Fiji are very different. The average yield per hectare (1909-10 to 1913-14) was 311 quintals but dropped heavily between 1918 and 1921. The reason is not in doubt; it was the labour troubles following the cutting off of the indentured labour supply from India. Up to that time, the industry was run on typical plantation lines and had gradually passed under the monopolistic control of the Colonial Sugar Refining Company. Drastic steps had to be taken and fortunately, the Company was controlled by courageous men. By stages the estates were cut up into peasant holdings which were leased to the freed indentured labour which was unwilling to work for a wage. A technical staff was employed to supervise and help the tenantry. In addition to supervising cultivation, the staff organizes cooperative harvesting by groups of tenants and supervises the loans given for purchasing implements and cattle and for the erection of housing. The tenant grows a portion of his holding in cane and is free to grow other crops on the remainder for his own use. The scheme, originally tentative, has proved so successful that only a small area for experimental purposes is now under direct cultivation by the Company. That was the position on the outbreak of war. From the time of the reorganization yields have gradually risen. Returning to the earlier average of 311 quintals per hectare, they now approach, and have on occasion surpassed 600 quintals. It is also on record that the yields obtained by the peasants are not less than those obtained on land under

dirrct cultivation; a fact which is in strong contrast with the earlier fact, quoted above, for the West Indies.

It would take too long to pursue the analysis through all the sugar-growing countries; two only can be mentioned. In contrast with the above, yield in northern India has risen from an average of 2600 lb. gur per acre in 1907-08 to 1911-12 to only 3500 lb. in spite of the substitution of Coimbatore canes. India's increased production results mainly from increased acreage. In British Guiana the yield of sugar per acre has risen from some 1.8 tons per acre around 1902 to over 3 tons. This apparent exception is probably due to the dominance of the sugar industry in the colony's economy.

There is, in the above examples drawn from the sugar industry, presumptive evidence that practical achievement is best attained when a technical staff is employed by the industry itself. A wealth of evidence could be gathered from without, pointing in the same direction, and one example may be given, Denmark is a country in which the technical services are employed by the industry, in England these services are official. In the former, the quinquennial averages for barley have steadily risen from 13.77 cwt. per acre in 1893 to '97 to 23.5 cwt. in 1933 to '37; in the latter, starting from 14.3 cwt. they remained fairly constant actually dropping slightly till 1918 to '22 and only rose to 16.7 cwt. in 1933 to '37. In Ireland, where the brewing interests take an active interest in the technical development of the crop, there has been a fairly steady rise from 16.7 cwt. to 20.3 cwt. over the same period.

Realization of high yields, thus, is dependent on many factors, some of which are economic; and not the least of these latter are the employment of the technical staff by, and its responsibility to the industry. That implies an industry organized in large units and this is generally opposed on social grounds' for it is commonly visualized as a plantation run on paid labour. Fiji pravides the answer to that objection; full development of agricultural wealth and social progress are compatible. The key lies in the organization which recognized the psychological distinction between research workers and "interpreters of research". Provision for research proper is best made by Universities and the necessary liaison effected by provision of facilities for research workers by which they will at intervals be able to conduct this more fundamental work at the local stations.

Home-Grown Food For The Empire

(Extract from the "United Empire" Journal of the Royal Empire Society, Vol. XXXVII. No. 1. 1946)

There is an inseparable cennection between a country's food supplies and its development-whether retrograde or progressive; its progress mainly determined by its food supplies and its means of prosperity is governed by its ability to provide enough home-grown food for the health and well-being of its people.

England's day as the stud farm of the world and for providing food as well as breeding stock (plant and animal) for her colonies and overseas possessions seems to be passing with the advent of new world conditions, and likewise the time seems to have arrived when her sons abroad should no longer rely upon the mother country in regard to these things; they should be produced locally, for the local product is better adapted to local conditions and is more 'tolerant' to disease than that which is imported whether plant or animal.

Most Colonies to-day rely too much upon imported foods, and it seems to have required a world war to illustrate the truth of this statement; the extent to which tye do so is marked by malnutrition and disease. If we examine the history of colonial development we find that it coincides largely with its trade history, and that means to a large extent its production of merchantable foodstuffs. In this connection it is interesting to recall Sir Frank Stockdale's wise advice to the people of the West Indies; he counselled mixed farming and endeavour to make themselves as self-supporting as possihle; this would include less food for export, at least for a time, but more home-grown food.

It is common knowledge that the development of most of the Colonies to-day suffers setbacks by disease in crops, livestock and human population. Why is this ? Because it is misdirected. Disease is not diagnosed to its source; it is treated superficially, and palliative measures alone are applied. It is

true that many diseases among colonial natives have been overcome by the application of scientific knowledge; scurvy, rickets, beri beri and elephantiasis are examples; but other diseases have appeared many of which were formerly rare or unknown among the natives and which are called "deficiency diseases", due to lack of vital ingredients in their food, of which so much is now imported.

In regard to malaria (and "Yellow Jack") much has been done to reduce its incidence by destroying the carriers, but it is a fact not generally realized that there would be far fewer victims of malaria if natural immunity were built up against it by proper food; it is also a fact worth noting that many people who live in the malaria countries of the Empire do not suffer from the disease because they have built up tolerance (or immunity) to it on account of their healthy constitution born of proper diet. The same principle holds good with other diseases such as bilharzia, amoebic dysentery hookworm, etc.

It should be realized that chemical warfare against disease is ineffectual and useless Chemicals are "dead"; disease is living. That should be the basis ef pathological research or rather of curative research throughout the Empire.

The Committee on Nutrition in the Colonial Empire which sat a few years ago (before the war) conducted searching enquiries into native diet in the Colonies. This Commission was characterized by all that was sound in the latest finding of nutriology, and it made many valuable recommendations; but have those recommendations been carried out ? Judging by the continued increase of malnutrition and disease it is safe to say they have not. Why ? Because, for one thing, trade interests have been too powerful; the native populations are a valuable market for many manufactured foodstuffs, including white refined sugar and denatured cereals, and it could require far more power than that with which such Commissions are invested to stop trade exploitation of the food supplies of the King's subjects abroad. This Commission lays much stress upon the need for foods containing the necessary vitamins, but rather than produce home-grown food containing these essential ingredients there has been too much reliance upon patent foods and chemical preparations to remedy the lack of wholesome food.

To-day there are more patent foods on the market than ever. People like them; they are tasty and save the housekeeper much trouble, but they are unwhloesome and can never provide the health which is inherent in home-grown foods. Furthermore they are very costly compared with natural raw foods, often costing from 10 to 20 times as much. Many are "pre-digested," and that alone sufficient evidence on which to condemn them as human food especially for the native people of the Colonies who have been encouraged to buy these preparations. It is of vital importance that the organs of man's alimentary system should exercise their special functions; if they are deprived of this exercise by being fed with predigested food nerve disorder will result. That is a brief summing up of the effect of patent foods as compared with home-grown foods.

In support of the statement that there is increasing malnutrition and disease in the Colonies it may be interesting to note some reports which have been published within the past year. From the Gold Coast we hear of increased cerebro-meningitis; 2,637 cases up to last May. It is suggested that this disease has spread by the habit of sitting close together indoors during the cold nights of the harmattan. Whether that is so or not, the real cause of the disease is evidently none other than ill-nutrition. Mauritius has recently suffered "the worst epidemic known" of infantile paralysis; the basic cause of this complaint is undoubtedly wrong feeding through neglect of home agriculture. Does not Mauritius concentrate on sugar production to the exclusion of other crops needed to provide wholesome food for the people ? In Mauritius we now learn that flour entirely replaces rice, and that 57,000 tons of it have been imported from Australia presumably white, denatured flour. What is to be expected when the staple food of a community consists of such a health destroying product?

Various diseases are evidently rife in Nigeria, for we hear that the hospital service is to be increased by over 200 per cent and 80 new hospitals costing £ 8,000,000 (exclusive of buildings) are to be constructed. In Bermuda an investigation is being made into the incidence of rickets. One would imagine that the local medical service would be competent to trace this deficiency disease to its source without the need for any special "investigation". What can be the cause of this

disease except want of proper food ? Perhaps some medical man would answer. It has been asserted by many eminent medical men that the health of a nation is far more dependent upon the agriculturist that upon the doctor; that statement is amply varified by observers from all parts of the Empire.

Broadly speaking, the health of all civilized countries to-day is declining. Why ? Surely not on account of lack of enough hospitals, shortage of medical services or of drugs, for these things have increased enormously. We must look for the explanation in the way people live and the greater quantities of drugs which have come into us ; people are ignoring Nature; the natural health-giving forces of the cosmos are being intercepted in many ways, and artificial forces are replacing them. People spend hours in unnatural postures at the wheels of motor cars; formerly they walked ; many are in bed asleep while the sun shines outside ; long evenings and far into the night are spent in dancing or playing bridge while health demands sleep. Such perversions are driving more and more people to drugs and decadence. The excessive use of chemicals, both in medicine and agriculture, is the great danger to present civilization. The harmful effects of chemical fertilisers, for instance, is only now being realised not, of course, by the manufacturers though not sufficiently to prevent their increasing application.

In regard to the increasing use of chemical fertilisers it is interesting to note that in Cyprus the Government is to subsidise the price of superphosphate at a cost of £ 53,000. With this stimulation the soil is expected to yield an extra two tons of grain for each ton of fertiliser. What a lot is excepted of the long suffering soils ! How can deed chemicals bring life (fertility) to impoverished soils ? That is a question which should be addressed to the government concerned, and a definite answer demanded. It is not realised that since the use of chemical fertilisers became a general practice the amount required to produce the same yield has more than doubled. Why? Because the soil is being forced to yield more than its natural capacity will permit ; the end result of this over-taxing of the soil, this perversion of Nature, will, of course, be more and more disease in the soil, in corps, in livestocks and in human beings.

Education in food values is sadly needed in all parts of the Empire, especially where the natives are ignorantly

sacrificing their home-grown foods to export trade for cash. In Africa, as no doubt in other parts of the Empire, the effects of this vicious policy is very evident. The natives, in many places, have abandoned their former habit of mixed farming in favour of monoculture, such as of ground nuts, maize, coffee, cocoa, etc. with the money so earned, in their ignorance, they buy the devitalised foods of commerce; tinned meats, tinned fish, refined white flour and sugar etc. and the effect on their health is becoming alarmingly apparent The next step in the downward path is for more hospitals and drugs in the vain attempt to overcome the natural consequences of abandoning their home-grown food. In the face of this terrible degradation it is only natural to ask what the various governments concerned are doing about it? A perusal of the records of administration in any Colony will show that nothing effectual is being done. Although many Commissions, enquiries and surveys are appointed from time to time—all very costly for the tax-payer—the evil continues. Recently in Southern Rhodesia a National Health Commission has been travelling round the Colony (for the last two months) " taking evidence" as though there were not already all the evidence needed for appropriate action in the cause of better health! That evidenoe lies in the condition of the native, as also of white school children—malnutrition and disease are rife, as any observer may see.

Let us consider in more detail the agricultural prospects of the West Indies. Sir Frank Stockdale's interesting address before the Royal Empire Society last May raised many points for profitable discussion. We all know that the most "important" export of the West Indies is sugar, For what and to whom is it important? Obviously for sugar refineries and trade, but less so for the inhabitants of the West Indies—especially the refined variety. Sir Frank Stockdale stated that "evert endeavour was made to make themselves (the West Indians) as self-sustaining as possible" and "it is to be hoped that the stimulus which has been given to local food production will not evaporate with the cessation of hostilities in Europe." The degree of self-support for the West Indians seems to be limited by the dictates of trade. It is absurd to say that an island so richly endowed by Nature as Jamaica must be dependent upon export trade to support itself in food supplies. Sir Frank apparently does not take this view, for he

says: "It is not pretended that a balanced dietary can be provided in the West Indies without some imports of food, but the local production should form an essential part of any modified agricultural system". He also says: "The main deficiences in the dietary are the 'protective' foods"; but he does not define them. If imported foods such as refined cereals, spirits, preserved milk etc. are regarded as 'protective' then there is all the more reason for excluding them. The real protective foods are those which are home-grown and are not subjected to the devitalising processes of commerce.

A very special home-grown or rather home-produced food, namely, honey, deserves mention; it is also a highly protective food and is the most valuable form of sugar. Honey is really "live" food, and unless it is "refined" it contains valuable vitamins; the late Dr. Rudolf Steiner referred to it as being the most important conveyor of life force from the cosmos to man; coming from such an eminent authority this should be a strong recommedation. Despite the nutritive value of honey its production is neglected; not by the bees, but by man. Recently in a broadcast a government official of the Union of South Africa said that £ 4,000,000 worth of nectar went to waste every season on the South African veld and considering that South Africa is largely barren terrain, what immense losses there must be in other more fertile countries where apiculture is neglected !

In regard to conservation and rehabilitation of the land Sir Frank Stockdale recommends "increased efficiency for the intensification of production, improvements in land tenure and agricultural methods"—all delightfully vague, if not meaningless abstraction. If "intensification of production" is to be brought about by the use of chemical fertilisers (as usually it is) then there will be no improvement in agriculture as a means to health, which should be the first object. The normal production of food supplies, of course, has been rudely upset by the war to such an extent that it is impossible to restore agriculture to what it should be in any short time. If such restoration is attempted by unnatural means; by excess of chemical fertilisers for the soil, by artificial insemination for cattle, by "vernalisation" of seeds, etc. then the position will become worse than ever, for Nature will rebel at these artificial innovations.

We are told that the main deficiencies in West Indian diet are the vitamin B group and supplies of Calcium. If the islanders grew sufficient cereals and ate the whole grain, whether maize, wheat, rice or other kinds of millet, all of which can be easily grown, there would be no lack of this vitamin. Good advice is not wanting as to health matters, but it is not implemented otherwise there would not be increasing malnutrition and disease.

Why are such crops as tobacco, rubber, cotton, sugar, etc. given preference before vital food crops? The answer can only be that trade demands rule the situation; if trade is to be the primary consideration then we must take the consequences. Truly the love of money is the root cause of malnutrition and disease.

When home-grown food such as cereals is deliberately devitalised for trade purposes and sold at prices far in excess of the value of the raw articles from which they are made and of far less nutritve value, how can health be maintained among the native populations? It is impossible; for these cereals are the staple food of millions. Unless there is some firm hand of administration to prevent this evil the Colonies oi the Empire will deteriorate in health and morale as they have already begun to do under white rule.

Potato Sprouts as a Source of "Seed"

By

PUSHKARNATH

(Potato Breeding Station, Simla, April 27, 1944.)

In the past various workers have attempted to devise ways of propagating the potato plant by such methods as would reduce the seed rate. The usual method is to plant either the whole or a part of the seed tuber. This asexual mode of propagation is now the universally-employed method of planting potatoes. The only other method so far known is to raise the plants from the true seed. The potato plant being heterozygous yields a variety of new types when either selfed or crossed seed, obtained from the barries, is sown. It is apparent that by this method it is neither possible to maintain a type nor is it profitable to raise a commercial crop, and its usefulness is, therefore, limited to scientific investigations and for the breeding of new varieties.

Seed tubers may be planted whole or as out-seed-pieces and it has been determined that a seed piece weighing about two ounces is the most desirable size to plant. Thus, for every plant about two-ounce weight of seed tuber is required as an initial start. This high seed rate has come in the way of expansion of potato cultivation, particularly due to transport and other difficulties created by the war. Scientists have, therefore, been busy in devising ways and means of overcoming these problems. In Russia Lysenko and his associates reduced the weight of seed required per acre by utilization of potato "tops", the remaining 90 per cent, or so of the tuber being used for food purposes. Similar methods of utilizing small portions of eyes called by various names as "chips", "peelings", etc., have been suggested by Copisarow 2 and Evans. Evans has been able to transport potato "tops" from one place to another by air and claims to have got satisfactory yields. The possibility of utilization and adoption in patato culture of the above and other similar methods has been recently investigated in this country by Pal & Deshmukh 4 and by Sen and Chakarvarti 5. They have determined that thin pieces from eyes or "peelings" give in general a poorer crop than that raised from the "tops". A suggestion has been offered that a closer spacing might compensate for the decreased

yields which they obtained in comparison to the controls (raised from whole tubers).

The above review will show that all the workers have hitherto agreed that detachment of the eyes with either a small or a large piece of the flesh is necessary to raise a patato plant. After the eyes heve been sliced off the—tuber it serves no further use except in the kitchen. Viewed from another aspect it would mean that a seed tuber, say with ten eyes, has a possibility of giving rise to ten plants at the most, and even this is not practicable as invariably three or four eyes are crowded towards the rose end of the tuber and these when removed serve as one seed-piece.

For the last ten years the Potato Breeding Station at Simla has been engaged on the breeding of better types of potatoes, and it has been necessary to multiply the new varieties rapidly from the original seedling plant. Multiplication of seed, even for a small-scale trial, takes several years.

The writer has been therefore, in search of a method by which a tuber could be made to give rise to a very large number of plants, and through persistent efforts has developed a method of tuberless sowing of potatoes which promises to be of value not only for scientific workers engaged in potato investigation but also for potato production, in certain areas.

This new method consists of raising the crop from the sprouts without damaging the eyes. The sprouts when they are about 1 to 2 inches in height are detached from the tuber and suitably planted in beds. Within about a week's time the sprouts develop roots, especially at the basal nodes and within two to three weeks' time the sprouts develop a crown of leaves and at this stage they can be transplanted. The "Sproutlings" are very hard and except for watering, during the first week or so after transplanting, do not require any other special treatment; in fact, they are as easy to handle as chilli or brinjal seedlings.

Several methods of inducing rapid, rooting of sprouts were investigated. Among these pretreatment of sprouts with hormoton was tried out but this did not show ony beneficial results. As the sprouts can be made root readily in soil, where as much as 100 per cent. success has been obtained, no pretreatment of the sprout seems to be necessary. It may be of interest to mention here that if has also been possible to get plants from sprout cuttings. Some varieties during storage produce

very long sprouts aud it has been a general practice to detach and throw away all such sprouts before planting of tubers. A long sprout can, however, give rise to three or four sproutlings if suitably treated. The details of the method of obtaining sproutlings are being published shortly.

The use of sprouts as seed is already proving very helpful in rapidly building up the stocks of the new potato varieties at the Simla Potato Breeding Station. There is every reason to believe that satisfactory yields can be obtained through the use of sproutlings. Experiments are in progress at Simla where ways and means of utilization of this method on a commercial scale are being investigated and the results of these findings will be published as the work progresses. In the meantime announcement of this method has been made as this may prove to be of much value, at least in some parts of this country, in the solution of some of the problems connected with the seed potato industry. Each seed tuber is capable of producing a very large number of sprouts. A four-ounce seed tuber would under normal circumstances yield two to four seed pieces, while a tuber of similar size, having about ten eyes, can be made to yield 20-40 good sprouts and the mother-tuber can still be utilized for seed purposes at the end. This is possible because a large number of sprouts develop after the first crop of sprouts has been removed and a tuber is capable of producing two to four such crops. Packets of sprouts have been successfully sent by post, and have rooted well when planted out.

As sprouts do not carry any part of the flesh or the skin, their use as seed reduces the possibility of transmission of tuber-borne fungal or bacterial diseases from the tuber to the soil. Again the tuber often does not show any visible signs of virus infection and it is not, therefore, possible to eliminate the virus infected ones before the sets are planted out in the field. On the other hand, the 'sproutlings' being transplanted after the first crown of leaves have appeared makes it possible to select only such 'sproutlings' as are apparently free from virus infection. A higher standard of health can thus be expected. The adoption of sproutling method in any scheme of scientific seed production will thus be of value.

Current Science, Vol. 14, No. 9 for the month of September, 1945.

Importance of Coal

Second in importance to human resources is power. Coal is not only the main source of power but is also the principal source of heat, the basis of most metal lurgical and industrial processes. For this reason all the World's big industrial centres lie near rich deposits of coal. Though India has ample supplies, they are concentrated in a few localities and the quantity of really first grade coal is limited. This means that failing the discovery of new large-scale deposits, considerable attention will have to be given to two aspects of the coal industry. The first is to cheapen and increase transport facilities, and the second is that we must cease to be prodigal of our patrimony.

After coal, water provides the most important source of power. But it would be a mistake to think that it costs next to nothing to produce power from water. Usually, costly works and transmission lines are necessary, and the interest on the capital cost of these often exceeds the cost of fuel required for a thermal station. It is only when a perennial fall is situated near an industrial centre that hydro-electricity becomes cheap enough for chemical and metal lurgical processes. To some extent that cost of storage required for power is reduced when the impounded water is at the same time used for irrigation. However, the amount of hydro-electric power that can be made available under a competitive economy must necessarily be limited, at the most about three million kilowatts. It would only be possible to develope all the vast potential resources of water power (one estimate is 27 million kilowatts) if we accepted the concept that the provision of facilities for electric power is a social service in the same way, let us say, as that of schools, hospitals and roads.

Indian Information, Vol. 16, No. 153, Feb. 1, 1945.

Date of Issue	Date of Issue	Date of Issue
24.X.58		
14-8-59		
3.12.62		

GIPNLK—H-40 I.A.R.I.—29-4- 5—15,000